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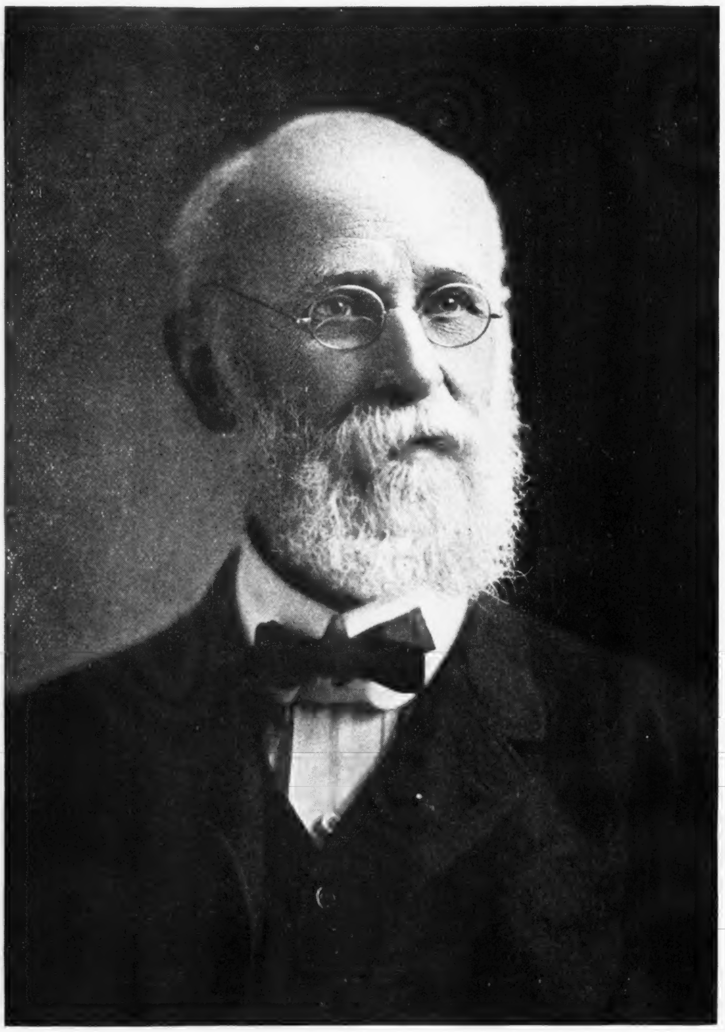

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(1836-1915)

Principal Works:

The Formation of Poisons, 1884.
Periosteum and Peridental Membrane, 1887.
Descriptive Anatomy of the Human Teeth, 1889.
Operative Dentistry, 1908.
Special Dental Pathology, 1915.

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ORIGINAL ARTICLES

A SYSTEM OF POSITIVE AND PAINLESS TOOTH MOVEMENT.*

BY RAY D. ROBINSON, D.D.S., LOS ANGELES, CAL.

WONDERFUL advances have been made in both the science and the art of orthodontia. Men of splendid mental capacity and wonderful technical ability have devoted their lives to its advancement, and where but a decade or two ago there was nothing of science, and but little of art, there now exists a splendid science and a beautiful art. The classification of malocclusion, the compiling of the knowledge of the causes of malocclusion, the advance in the knowledge of the surrounding tissues and the changes which take place in them incident to tooth movement, the improvement in types and designs of orthodontic appliances and the materials from which they are made are all worthy of our highest praise and commendation. The fame of the men who have done these several great works should be imperishable.

In offering criticism of the appliances now before the profession, your essayist wishes it distinctly understood that he is not criticizing the appliances, for their day, nor their creators at all. They have been splendid appliances in their time. Their development marked distinct steps in the evolution of orthodontic appliances, but it would be foolish to assume that, in them, perfection had been reached, or that it ever will be reached. It is only by analyzing the faults of these appliances, and comparing them with the one to be shown at this time, that we can arrive at any just conclusions regarding the value of the new type, as *it* will be found valuable, only if it overcomes faults found in the existing appliances.

Let the essayist then point out some of the faults of the present day appliances, as he sees them, and then consider the efforts he has made to overcome these faults.

First we will take up the older appliance of expansion arch and wire ligatures, as that has probably been more generally used than any other.

Objections.—First.—Any tooth movement secured by an appliance depending on the screw for development of force must be intermittent, and the force itself must rapidly vary in intensity, for a positive tooth movement

*Read before the Illinois State Dental Society, May, 1915.

is secured at the time the screw is tightened, and as the tooth moves the force rapidly lessens until in a short time no force is being exerted.

Second.—Any movement secured by the tightening of non-elastic ligatures connecting a tooth and a rigid, or semi-rigid, bar must be intermittent and again the force rapidly lessens until none is exerted. Movements of this character tend to produce soreness, unnecessary loss of bone tissue, and require longer periods of retention than those secured by an appliance in which the force is constant and uninterrupted over a long period of time. The abrasion of the tongue and lips by wire ligatures is a serious fault. Other objections are found in the use of ligatures of any kind in the injury done to the gums, and because they furnish a lodging place for accumulations of food between the teeth. Decalcification frequently results in these places. Again the ligatures become loose and displaced, either through design on the part of the patient, or through accident or stress of mastication, allowing a recession of the teeth, consequent soreness and a retarding of the progress of the work.

Third.—In the appliance depending on the screw, the force is developed at a point far distant from that to which it is to be applied, and must be transmitted through a long curved wire, which makes the application more uncertain than when the force is developed at, or near, the point where is to be applied.

Fourth.—The inability to lengthen any intermediate section of the arch often proves a very disagreeable feature, as, for instance, when the central and cuspid are lying in close approximation, or in contact, necessitating their being moved apart with but little labial movement; or in a similar condition in any curved part of the arch, where the teeth are to be carried along the line of occlusion, rather than labially. In such cases the movement mesially or distally without much labial movement is very difficult.

Fifth.—The type of appliance under discussion usually depends on one tooth in each lateral half of the jaw for its anchorage, and they must bear the full amount of force necessary to move all the anterior teeth, which is frequently sufficient to tax their support beyond the limit.

Sixth.—With this type of appliance, the teeth when moved must be tipped; their bodily movement is out of the question.

Seventh.—The constant surveillance which it is necessary to keep over this appliance, and the frequent applications of force necessary to keep the teeth moving are distinct disadvantages.

Eighth.—After a case has been completed the appliance must be removed and another constructed and adjusted in its place for retention. The construction of a proper retaining device often proves more difficult than the correction of the case itself. This is also a serious and unhappy time for the patient, as the construction of an appliance on teeth that have been moved, and are still loose, is usually a very painful operation.

Tube and Pin Appliance: Objections.—First.—The technic necessary properly to construct and apply this device is so severe and exacting as to place it out of the question, except in the hands of the most skillful technicians. Many of the men who have had their training in the construction

and use of this appliance from the best authority, have given up its use, and others say they use it only occasionally.

Second.—The wire when small enough to serve properly for root control is not strong enough to expand properly a mature dental arch without the use of loops, for which there is no provision. Many are securing their expansion with the older form of arch and finishing with this type.

Third.—Root control is only feasible in a part of the arch. Those cases requiring great expansion, with consequent tipping of molars and bicuspids with the older appliances, are still being completed with the latter teeth badly inclined buccally.

Fourth.—The rotation of teeth requires either the use of rubber wedges or ligatures.

Fifth.—This appliance is subject to the same disadvantages of the abrupt application of force by the screw action as was the older form, but in a less degree.

Sixth.—If a band breaks or becomes uncemented, it is necessary to remove the whole arch before the band can be replaced.

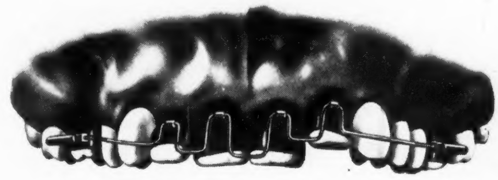

Fig. 1.

Your essayist is deeply sensible of the difficulty before him when he attempts to convince you that any appliance will meet and overcome all these objections, without itself developing other objections. To that end he will now show the appliance which he wishes to present, and its operation, after which he will take up the bad features of the other appliances as he has enumerated them, and we shall see if they have been met and overcome, or if he must be branded as an iconoclast—one who tears down and never builds up. After that it will be for you to say in your discussion whether the appliance, as he shows it, has other faults.

Except the force of gravity, there is probably no force in nature so constant in its operation as that of a coiled spring, as even the pressure of the atmosphere varies with the temperature, the elevation above or below sea level, etc. The coiled spring, in season and out, high or low, hot or cold, always works and never varies. Closely allied to the coiled spring is the looped spring. It has all the advantages of the coiled spring, and has the further advantage that it lies in a flat plane. It is this force which we are to consider today, with a new form of attachment to the teeth.

With your permission, the essayist will digress long enough to explain some of the steps he has taken in developing the appliance. The appliance was first made with short, split, round tubing soldered to the labial

surfaces of the incisor bands near the gingival line. The arch made of .022″ wire was threaded at its ends which were placed in tubes on the molar bands. The arch wire was engaged in the short split tubes, and at the points where it emerged, was bent sharply toward the incisal edge. It was allowed to extend nearly to the cutting edge, and was then bent at right angles and passed to the next tooth, when it was bent at right angles again toward the gingival line. When it reached the line of the split tubing it was bent again at right angles and passed through the next tubing and so on for each tooth (Fig. 1). By the proper bending of the wire, pressure could be brought to bear on the incisal ends of the teeth in the lingual direction, and at the same time it would pull labially on the gingival portion of the tooth. In this way the apeces of the roots were moved labially, and the incisal ends lingually. The appliance as described, did very good work in certain instances, but its usefulness was restricted to a very small percentage of cases. The things of greatest interest learned were the length of time such an appliance would continue its pressure, and the absence of all soreness.

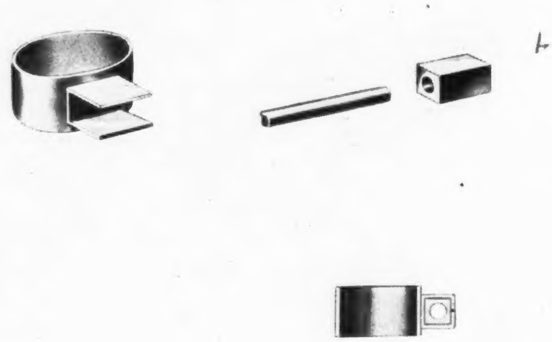

Fig. 2.

After this, came the thought that better control could be secured if the rotation of the arch wire in the tubing could be prevented. To this end square split tubing was secured, and a square wire used, but a new difficulty immediately arose. When the wire was made into loops, it was found that no two loops had the same resistance, for a square wire bent in the direction of one side will not have the same resistance as though it is bent in the direction of a corner, and all the different angles between the flat side and the corner give different results. A triangular wire was then tried, then a flat wire with a groove on one side to provide means for locking into a suitable form milled from solid metal and soldered to the tooth bands, but they all presented difficulties. Then came the idea of squaring a round wire just at the points where it was to be locked to the bands. When a wire small enough to give just the right delicate resilience required for the work was squared, the squared portion was too small to handle, and when it was made large enough to handle, it was too stiff to give the results desired. After a period of study, came the idea of using hollow square blocks soldered on the arch

wire at the places where the attachments were to be made (Fig. 2). That was the first real step in developing the present appliance. The ability to lock the arch wire itself into the seats without soldering on attachments was at first held by the essayist to be a necessity, but after once preparing an arch in this way, it developed that the technic is so simple as to bother no one. The possibility of making an error in alignment in soldering the block to the arch is practically nil, and the advantage gained is so great that there can be no question that the use of the round wire and the soldered blocks will be accepted as more desirable than the use of the angular wire.

Fig. 3.

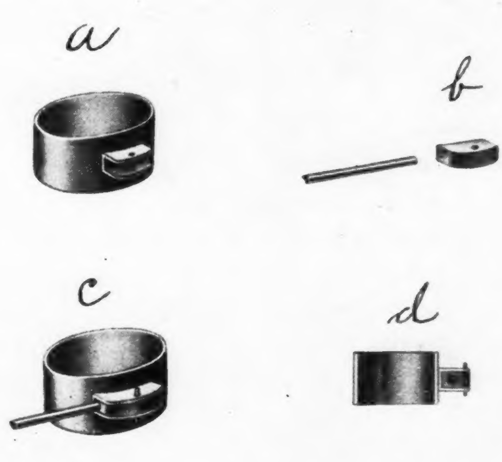

Fig. 4.

Iridio-platinum seats into which the blocks accurately fitted, were constructed and soldered to the tooth bands. When the blocks were soldered to the arch wire and locked into the seats by bending their edges, the attachment between the arch wire and tooth was rigid (Fig. 3). The appliance was first published in this form, and much good work was done with it as it was then used, but a serious fault developed. When the seat was made thin enough to bend over and lock the block in place, it was so frail that it often became loose under continued pressure and the stress of mastication, allowing the block and arch wire to slip, and thus the force was not applied as it should have been. Then began the hunt for a lock that would hold or release the wire as

desired. No fewer then sixteen good, bad and worse forms of locking devices were tried and cast aside. Then came the fortunate day when the form now used was designed. It has been in use eight months. More than a hundred dozen have been used, and so far as can be learned, not one has allowed the wire to slip. Never have they failed to release when release was wanted.

The attachment between the tooth and the arch is made by an interlocking seat (Fig. 4*a*) and block (Fig. 4*b*), the former being soldered to the tooth band, and the latter to the arch wire. The seat consists of a flat oblong base and two flat parallel walls rising at right angles to the base. The walls are rounded at the top, and each is pierced near the top with a small hole, the two holes being in alignment. The seat is made of platinum-gold and is .022″ thick. The distance between the walls or across the base of the seat is .040″.

The block is of platinum-gold, but harder than the seat, and is .040″ thick and shaped to fit inside the walls of the seat above described, except that it is .005″ greater in elevation than the side walls of the seat, which provides means for its being forced into the seat, with a pair of pliers, when there is stress on the arch wire to which it is soldered. The block (Fig. 4*b*) is pierced by two holes, the larger runs longitudinally and its bore is equal to the diameter of the arch wire used, or .020″. The smaller hole is through the transverse diameter of the block near the top and is in the exact place to be brought into alignment with the two holes in the seat walls when the block is forced into place in the seat. The block is locked into the seat by placing a delicate pin through the seat walls and the block (Fig. 4*d*). When so locked, no play is possible. The two parts are made to fit to the minutest fraction of an inch, and as they have three flat walls in apposition, and are locked firmly together, they do not permit of any play whatever. The molar and anterior attachments are alike, except that the molars are the longer (Fig. 4*c*.)

Fig. 5.

It is not to be supposed that the complete technic for all classes of cases can be given in an essay of this character. A general outline of the technic is all that can be attempted.

The technic of construction is very simple. The tooth bands are first constructed, and to their labial surfaces are soldered the seats (Fig. 5). No necessity exists for getting them into alignment with each other, or of getting them at exactly right angles to the long axes of the teeth. If they be placed somewhere nearly at right angles it will be sufficient. After the bands with

the seats attached have been cemented to the teeth, the arch wire is prepared as follows: A piece of arch wire is selected and enough blocks to correspond with the number of tooth bands are threaded on the wire; a molar block being first and last with the anterior blocks between. One of the molar blocks is now soldered to the wire. The block is next introduced into the seat in the mouth and the arch wire is bent in such a way as to bring it to lie through the next seat. If there is to be any change made in the relative position of the molar and the first tooth to be engaged, anterior to it, a loop should be made in the wire in such a position that it will lie near, without touching, the gum, and then bring the wire to lie through the next seat. When this has been done, bring forward the next block on the wire until it is approximately in the proper place to go into the seat. Next, with a pair of crimping pliers having a delicate projection in one beak, crimp the block on the wire; now the block may be forced into the seat and if it not in its proper place on the wire, it can be forced into place by grasping the ends of the seat and block in a pair of pliers and bringing force to bear. As they are exactly the same length, the block must go to its proper place. The arch wire is now removed from the mouth and the block soldered, there being

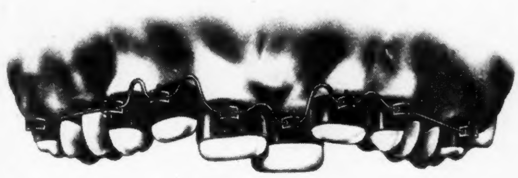

Fig. 6.

little danger of displacing the block on the wire because after crimping the block, force must be used to change its position on the wire. Each block is, in its turn, brought to its proper place and soldered in a like manner, loops being formed wherever necessary. After the last block has been soldered, any remaining portion of the wire is cut off. It will now be found that when the arch is placed in position each block will lie passively in its seat (Fig. 6).

When the work required of the arch wire has been determined it is bent into the necessary form and is then replaced in the mouth and each block is forced into its corresponding seat and locked there. If an effort is to be made to bring all the teeth into harmony with the line of occlusion with one application of force, measurements of the incisors and cuspids will be made, and by using the Hawley arch predetermining transparencies the true arch for the individual case will be determined. Guessing is eliminated with the diagram of the true arch at hand. The loops in the expansion arch already constructed will be opened, closed or twisted, as may be required, to bring the wire arch to the size and shape of the ideal dental arch determined on, with each block occupying the position in the ideal arch that the labial or buccal side of the tooth should occupy. After this has been done, the arch wire is placed in the mouth and each block in its corresponding

seat. If we could depend on a wire developing onehundred per cent of resilience, nothing beyond this would ever be necessary, but that of course we cannot do. It will be observed that the attachment between the tooth and the wire arch is rigid. There is no chance for any play between them. Any force brought to bear through the arch wire must, in time, be registered in the tooth, and, as the attachment is rigid, the tooth must move as a whole, the root as well as the crown. In fact the control over the tooth is absolute. It will be argued that so small a wire will not produce enough force to move the teeth in a mature jaw, or expand an arch. The answer to that argument is that it does not require much force to do anything necessary in the moving of teeth, if that force be continuous over a long period of time. The arch as described is a looped spring and the essayist will show you proof that it will

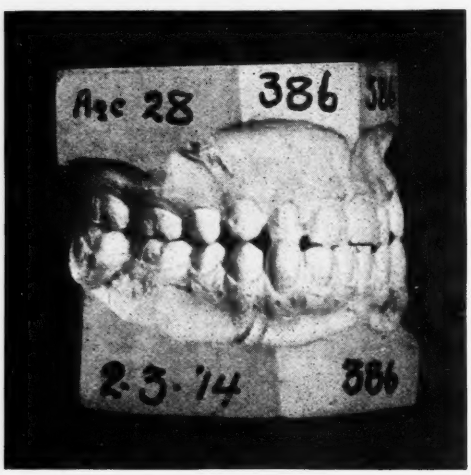

Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

continue its pressure over a period of four months without tightening, and that it will expand an arch, and that it will move teeth in an adult jaw, and move them so gently, slowly and steadily as not to produce even the slightest soreness, and that when they are so moved they require but a minimum of retention.

Model shown in Fig. 7 is that of a lady of twenty-eight, who had a cuspid

extracted when she was fifteen years of age, allowing the lateral and first bicuspid to come into actual contact with a decided lingual movement of all the superior incisors. The appliance was adjusted on February 10, 1914. It was tightened on March 3, April 7, and May 5. The teeth continued to move until the latter part of June, after which nothing was done until September 8, when certain events in the lady's career made it highly desirable that the appliances be removed. This was done, and a bridge was made by her dentist to supply the missing cuspid. The model shown in Fig. 8 was made on January 12, 1915, more than four months after retention was

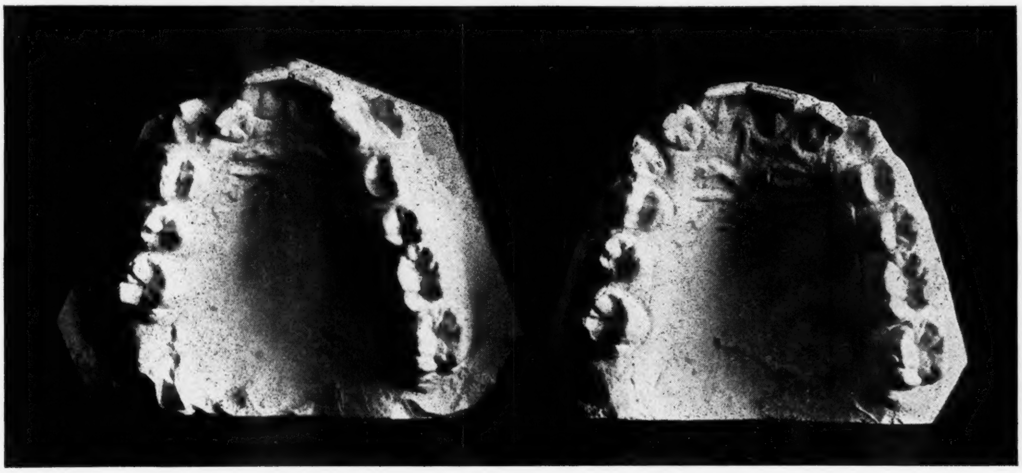

Fig. 11.

Fig. 12.

Fig. 13.

removed. The occlusion originally was such that the incisors had been much worn, and when they were placed in their proper places there was no overbite. The retention period was less than three months, and yet it will be observed that only one tooth, the right central incisor, has shown any movement, and it but the very slightest.

The case was selected for illustration on account of the advanced age of the patient and the difficulty usually attending the retention of such a case at that age.

Fig. 9 shows a case of a boy of fourteen. The model was made on June 11, 1914, and the upper appliance adjusted on June 18. The writer's absence

from the city followed by the patient's absence prevented even an inspection of the case until October 14. The change was so startling that the appliance was removed and a model was made, which is shown in Fig. 10. It will be observed that there has been but little expansion in the molar region, and that there is not enough room for the cuspids, but it will also be observed that *there has been a great amount of movement and that all of the movement of each tooth has been in the desired direction.* Fig. 11 shows what the second application of force accomplished.

Fig. 12 shows a case of a boy of eleven. The model was made on September 16. The upper appliance was adjusted on September 30. Permission to allow the case to go three months without further attention was asked. Nothing was done until December 16, at which time the model shown in Fig. 13 was made.

The work shown was all done with a platinum-gold wire. Your essayist at a meeting of the American Society of Orthodontists last year said that, if he could get a steel wire with a noble metal sheath so that he could solder

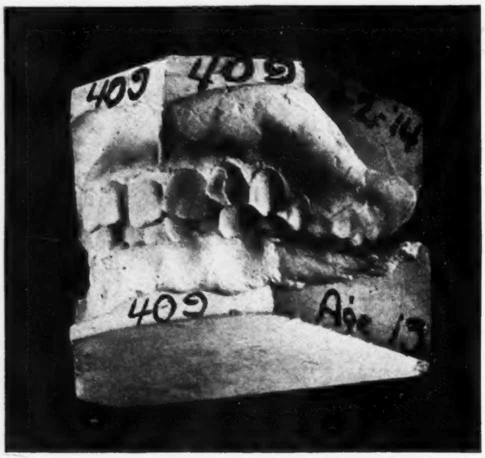

Fig. 14.

to it, and could then find a proper means for tempering it, he could finish sixty per cent of Class I cases with not more than two applications of force. In answer to his prayer for wire with better resilience, listen to this quotation from the report of Dr. Weston A. Price, chairman of the Research Committee of the National Dental Association:

"Tungsten with its elastic content about twice that of steel, its melting point nearly twice that of platinum, its stiffness about six times that of thirty per cent iridium in platinum and with the remarkable property that it does not anneal or lose its stiffness and elasticity even when heated to the melting point of gold, makes it particularly adaptable for many parts of orthodontia appliances. After testing tungsten in practical use in expansion arches for about a year, and after extreme laboratory tests, we believe it to be superior for various forms of expansion arch to any metal that we have heretofore found for the following reasons: The required elasticity and rigidity can be secured with smaller sizes. Attachments of any kind may be made to it with pure gold or with any karat of gold solder, without changing its stiffness at the point of attachment. The entire appliance and its con-

necting parts can be of such metals that not only is there practically no discoloration or oxidation of the appliance, but also with the very slight electrolytic potential difference between the various parts, thereby reducing the electrolysis.

"This great elasticity of tungsten makes it particularly desirable and adaptable for the new type of expansion arches, a much smaller size of

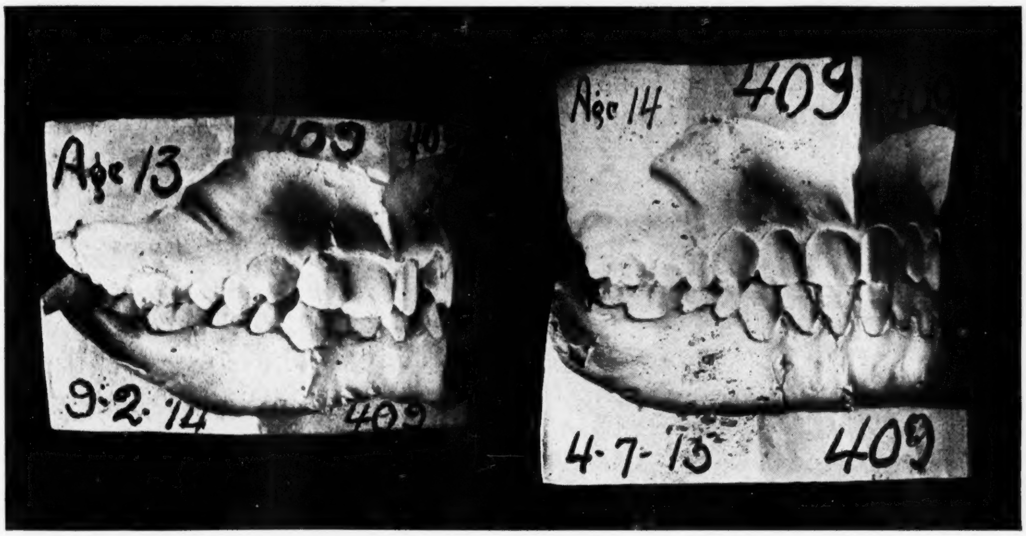

Fig. 15.

Fig. 16.

tungsten can be used for this purpose than may be in the other metals and still have a large factor of stiffness for expanding the arch. The attachments can be made with any gold solder without danger of softening or annealing the arch and the bends can later be taken out cold, if not sharp, and if sharp, by heating to a dull red while bending. It does not crystallize and break like gold clasp bar, and similar metals, under the stress of mastication."

With such a wire as Dr. Price describes it is possible, in a large percentage of cases, after drawing a diagram of the ideal arch for each case with the aid of the Hawley arch predetermining transparencies, to construct a wire arch which will, when properly locked to the teeth, bring them into harmony with the line of occlusion without further attention. In another large percentage of cases it will require two applications of force. The first to secure the proper width to arch, before attempting the placing of individual teeth, such as rotation, etc., and the second to secure such placing and rotation. In others it will require more than the two, but your essayist readily believes that there is no case, of suitable age if it is amenable to any treatment, which cannot have the best, that is possible for the case, completed in a half-dozen applications of force, and that without pain.

In August, 1914, there was placed in your essayist's hands a piece of tungsten wire with a gold-palladium surface, such as has been produced by the Research Committee of the National Dental Association. The case shown in Fig. 14 was selected as suitable for a trial of this wire. Very careful and exacting measurements of the teeth were made and the true arch was determined to the best of the operator's ability. The attachments were made and cemented to the teeth. The wire arches were then constructed as described above. These were both attached to the teeth, as given in the technic, on September 2, 1914. The case was seen on the average of once a week, but only for observation, as nothing was done until the appliance was removed on April 9, 1915, at which time the work had developed to the point shown in Figs. 15 and 16. Your essayist makes no claim that normal occlusion was then secured, but leaves to your own judgment the value of an appliance which will perform the work shown in these two illustrations without attention and without even tooth soreness.

Your essayist wishes it distinctly understood that in ordinary handling of a case, he would not permit it to go so long a period without attention. His object in doing so in this case was to allow the appliance to work to the limit of its ability and in so doing test the value of the new tungsten wire.

Let us now see if this appliance has overcome the objections which its creator has raised to the previously existing appliances, and if it has overcome them, let us see if it has developed any new faults. If it has overcome these objections and has not developed a new lot of troubles peculiar to itself, it is worthy of your attention—otherwise, it should be discarded.

To state the difference in the operation and the principles of force employed by the different appliances in a few sentences and bring these differences sharply before you so that there may be no confusion in your minds, let it be said: The older Angle appliance uses a rigid arch formed in the shape of an ideal dental arch and depends on the use of ligatures to bring the teeth to this form. This is supplemented by the ability to lengthen the arch by a screw at either of its ends.

The tube and post alliance uses a semi-rigid arch bent to the form the teeth occupy in malocclusion and depends on the force produced when, at intervals, the arch is removed from the mouth and bent into a shape more nearly approaching the ideal dental arch. This force is supplemented also by the ability to lengthen the arch by a screw at either of its ends and by the use of wedges for rotation.

The appliance presented here depends on a non-rigid arch formed into the shape of the ideal dental arch, which is so flexible as to permit of its being bent into the form of the dental arch, with the teeth in malocclusion, and so resilient, by virtue of its composition and the loops into which it is formed, that it will return to its original form of an ideal dental arch and carry the teeth with it. The greatest feature of the appliance is that by virtue of the loops into which the wire is bent, it is capable of exerting force over a long period of time, and is capable of moving a tooth relatively great distance without being tightened, *or at any time exerting more than a very little force.*

The *objections to the older Angle appliance* were: First, to the intermittence of the force developed by the screw. That has undoubtedly been overcome.

The second was to ligatures, there being many reasons why they are objectionable. This appliance uses no ligature. The third was to the fact that the force was developed at a point distant from the one where it was applied, and was not always reliable for that reason. In this appliance the force is developed at the point where it is used.

The fourth was to the inability to lengthen any intermediate section of the arch. That has certainly been overcome. The fifth was to faulty anchorage. In this appliance reciprocal anchorage is carried to the *n*th degree. The sixth was to the inability to secure bodily movement of teeth. With this appliance there is perfect control over all the teeth.

The seventh was to the constant surveillance and attention which the appliance required. That this appliance needs little of either is quite evident. The eighth was to the necessity of making retaining devices, and the length of time it was necessary to wear them. This appliance is its own best retainer, and the retention period is much reduced.

The *objections to the tube and post appliance* were: First, to the severity of the technic necessary. The necessary technic for constructing this appliance is simple and is along lines easy to follow.

The second was to the lack of provision for proper expansion. That has been overcome in this appliance, and with a wire but two-thirds the diameter of the one previously used.

The third was to lack of root control in the molars and bicuspids. This appliance gives control over all the teeth. The fourth was to the lack of ability to rotate teeth without wedges or ligatures. That surely has been overcome.

The fifth was to the abrupt application of force by the screw. That too has been met and overcome. The sixth was to the difficulty of repair. In this appliance any band can be removed and replaced without disturbing any other part of the appliance.

The question now arises: Does the appliance as described have any faults, and the answer is yes. The lack of soreness has, strange to say, proved a bad feature, for the reason that when there is no soreness, the patient is very apt to put too much strain on so delicate an appliance by biting into apples, hard toast and other substances, and frequent breakage of the arch wire has resulted, but the new tungsten wire has overcome even this.

A WORD ABOUT FAILURES.

By Frank R. Woods, D.D.S.
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WE all dislike to drag these skeletons from their closets, and so, perhaps, the greater need. Our successes are their own monuments, and beholding them; attendant difficulties are forgotten in the joy of accomplishment, but if success be but qualified, or even substantially lacking, then is no time to assign unsatisfactory memories to forgetfulness, but rather by careful analysis, to fix responsibility though it may not always reflect unlimited credit upon the analyst.

We may give but short shrift to those cases which are doomed by the neglect or persistent indifference of the patient, or the lack of insistence upon proper care on the part of the parents, for they occasionally constitute circumstances beyond our control.

The greatest enemy of fully successful results is the lack of the highest ideals, or failure to adhere to them strictly, under trying conditions. It may seem so much easier to accept a compromise which seems to promise a pretty good working occlusion, but of all the snares ever set to vex the orthodontist's soul, this is the most surely Satan's own. There is but one arrangement of the human denture that is truly efficient and in harmony with normal physical development of the head, and for that matter, of the whole body, and that is the arrangement described by Doctor Angle as "Normal Occlusion". To be sure there are cases of advanced development where the deviation from this ideal is of such a nature and of so great extent that it is impossible, or at least, impracticable, to restore and maintain the denture in pure normal occlusion; but if we resign our attempt only after the utmost patience has proved unavailing and every expedient insufficient, we shall certainly have accomplished a much nearer approach than if we begin by desiring a compromise, which orthodontically, is but a qualified failure. For a given tooth in a given denture there can be but one correct position, i.e., for each tooth there is an intersecting point in the mesio-distal, bucco-lingual, and vertical planes which a given point in the crown of that tooth must coincide with in order that it may be in harmony with its fellows in the same arch, and that that arch may functionate efficiently with its opponent. In just the degree that it deviates from this point, will harmony in the arch be marred, efficiency of function be impaired, and facial symmetry and the beauty of harmonious features be destroyed. The time is now with us when careful parents bring their children to the orthodontist while they are yet little tots of four or five years for his opinion as to whether or not normal development is occurring. In many cases in which nature seems reluctant to provide needed space for developing teeth, a simple appliance placed in good time is sufficient to provide the necessary stimulus for growth, and we have excellent reason to believe that a long and tedious treatment has been averted, and a more nearly ideal result attained than if the child had been allowed to go on and erupt a considerable part of its denture in a

more or less serious malocclusion, because by early interference, the departure from the normal ideal at any time has been minimized. It is obvious that the less deviation from the ideal a case presents at any point of treatment, the more readily may it be made to conform to the ideal in its result, and conversely, the greater the deviation, the greater the difficulty of correction, and the less the approach to the ideal. In view of this, does it not seem wholly worth the while of general practitioners of dentistry and orthodontists alike to let their cry of warning to parents be to seek competent advice early and thereby lessen future trouble for themselves and promote in the highest degree possible the dental welfare of their children? So much for delayed treatment as a contributing cause for our failures.

In the matter of choice of appliances, of course the one constant requisite is efficiency, the appliance must accomplish the desired work with certainty, but only second to this is the ancient virtue of simplicity. The intrinsic relative excellence of efficient appliances will be in direct ratio to their simplicity; the simpler an efficient appliance, the more nearly ideal is it. The less number of banded teeth, the less number of contacts of arch and tooth, the less number of angles favorable to the retention of food-debris, formed by the appliances, the greater the likelihood that the teeth will survive treatment free from decalcification, and the greater the probability that the gums and peridental tissues will not have sustained serious injuries or have experienced infections which, even though apparently of but slight significance, nevertheless leave the tissue involved in a condition not quite so good, not quite so favorable to their future health, as they once were. All too little concern, in a large percentage of cases, is given to slight injuries of the soft tissues by impinging arches and unwisely placed ligatures, so that when parents considering orthodontic treatment for their children, express concern lest they suffer injury through the operation, we are forced to concede, at least mentally, that it is altogether likely that they have seen cases which furnish them just grounds for apprehension.

We shall now approach the subject from the standpoint of an unsatisfactory ultimate result, though an apparently satisfying correction was obtained, but which did not stand. A most prolific cause of this class of failures I believe to be insufficiently long retention. Assume first that the case is one of twelve or thirteen years of age when treatment is begun, and therefore of thirteen or fourteen years when active treatment is finished. The patient has erupted a nearly if not quite full denture, except third molars, before correction is attempted. This means that the teeth have accommodated themselves in their positions in the process to a considerable degree, to their conditions of abnormal stresses, and the adjacent and associated hard and soft structures are developed in conformity to this malocclusion. It is quite superfluous to say that the mere moving the teeth into approximately normal occlusal positions will not accomplish a permanent correction. We merely create again a plastic condition of immediately surrounding tissues in which the teeth are free to assume whatever positions of malocclusion the then active forces shall dictate. Each tooth will follow its line of least resistance under those forces and come to rest at their point of balance. The change of tooth position may individually be very considerable and the structural change in the immediately surrounding

tissue will be proportionately great, but the changes in the bony structures a little more remote will not occur with the same promptness, nor will changes in muscular attachment and muscular structure be as immediate as in the members to which the corrective force is directly applied. We therefore, at the conclusion of active treatment have, instead of a harmonious whole, a most complicated structure entirely out of balance. Something must undergo a change in the direction of restoring harmony in the associated parts. If the arches are restrained within due bounds, though the greatest possible freedom must be given individual teeth consistent with such restraint, for a long enough period, these more remote hard and soft tissues will answer nature's demand for harmony and a permanent correction will be much more likely to result. But this permanent correction will not be simply straightened teeth, but what is far more, it will be a regenerated facial and cranial structure. This is true Orthodontia, requiring the utmost skill, the most unfailing judgment, and the sublimest patience on the part of the operator, and the most sympathetic comprehension and fullest co-operation on the part of the patient and parents.

MALOCCLUSION AND MOUTH-BREATHING.*

By W. F. Taylor, D.D.S., Fond du Lac, Wis.

ORTHODONTIA is that science which has for its object the correction of the malocclusion of the teeth and facial deformities.

Malocclusion is a deviation from normal to such an extent as to interfere with the functions of the teeth. Orthodontia being that science which deals with the malocclusion of the teeth, I believe you, of the medical profession, might be interested in the etiology of Class II, Division 1, cases, being those malocclusions which are characterized by the distal relation of the lower arch to the upper. The upper arch is narrow with protruding anterior teeth; undeveloped mandible, with a receding chin, and the patients are mouth-breathers with short upper lips.

Mouth-breathing has long been recognized as a cause of malocclusion and the result of adenoids. There are other things which cause mouth-breathing, but a large percentage of mouth-breathing in children is produced by adenoids. Adenoids may be defined as the hypertrophy of the lymphoid tissue located in the naso-pharynx. Lymphoid tissue is present in all children and becomes the cause of mouth-breathing only when it is infected and congested to such an extent that it extends downward and forward until it comes in contact with the soft palate and closes the naso-pharynx. In some children the congested condition becomes sufficient to produce an obstruction of the nasal tract only when lying down. This mass of lymphoid tissue is a portion of a continuous ring, which encircles the pharynx, and is known as the ring of Waldeyer. Owing to the ease with which this lymphoid tissue becomes infected, it is also known as the "vicious circle."

*Read before the Fond du Lac County Medical Society, May 12, 1915.

The enlargement of the mass of lymphoid tissue in the naso-pharynx posterior and above the soft palate, can only be seen with a reflected light and a pharyngeal mirror. However, the clinical picture of the patient is enough to prove the presence of adenoids to one familiar with the condition. The patient has the "vacant stare", which is better described as follows: Upper lip is short, the external nares undeveloped, lack of development through the nasal region, antral cavities undeveloped, which gives a narrow face, mandible undeveloped and a poorly developed chin. The eyes often appear large and staring, which is the lack of development of the nasal regions. Patients suffering from this condition all present the same picture. As these patients grow older the conditions become more marked.

Owing to mouth-breathing, air does not pass through the nasal cavities, and as a result no atmospheric pressure is exerted upon the walls of the nose. At birth, the maxillary sinus is not seen, and the roof of the mouth is nearly straight. The inferior turbinated bones lie close to the floor of the nose. If the child breathes normally the nasal cavity will develop, the floor of the nose will be carried downward, and the septum will have room to grow. The growth of the nasal cavity affects the growth of the maxillary bone and likewise anything which affects the growth of the maxillary bone will influence the nasal cavity.

About three-fourths of the lateral walls, and four-fifth of the floor of the nose is made up of the superior maxillary bones. It is therefore easy to understand how the lack of development of the nasal cavity will influence the maxillary bone, and how the lack of growth of the maxillary bone will influence the nasal cavity. As the child grows the nasal cavity increases in size by a growth downward and outward.

In normal breathers, the mandible is held in place by atmospheric pressure. When the mouth is closed one generally swallows, which brings the tongue up against the roof of the mouth and causes it to fill the whole oral cavity. As a result of the tongue occupying this position, pressure is exerted on the lingual sides of the upper and lower teeth, which forces them buccally. In mouth-breathing the tongue does not exert any force on the upper teeth, which allows the upper arch to remain undeveloped, and it is therefore spoken of as a narrow arch. The tongue lies in the lower portion of the oral cavity and does not touch the lower anterior teeth. The mandible drops downward as a result of the loss of the atmospheric pressure, and the muscles which depress the mandible hold the mandible from developing forward, owing to the weight which they exert on the anterior portion. The mouth being held open, the molars are separated enough to allow the lower molars to lock distal to the upper molars.

As the action of the muscles is abnormal, the upper lip does not exert pressure on the upper anterior teeth, thus allowing them to protrude. With the mouth open and the lips parted the lower lip drops back against the lower teeth, and then the upper portion of the lower lip exerts pressure on the lingual surface of the upper teeth. The irritation of the upper teeth causes the lower lip to become thicker, which in turn causes the upper teeth to protrude farther.

The treatment of these cases in brief is as follows: Make certain that all nasal obstructions have been removed; expand the upper dental arch,

which is the only remedy for developing the nasal cavity; retract the protruding upper anterior teeth and move the lower teeth forward, with the idea of establishing normal occlusion.

The first models are those of a normal breather. You will observe that the lower arch has a certain relation to the upper arch, which is indicated by the black mark on the first molars. The dental arch forms a nice curve and the upper anterior teeth are in contact with the lower teeth. The upper and lower lip can be closed, and nasal breathing is the normal state of affairs. The mandible is properly developed, and the patient has a normal chin.

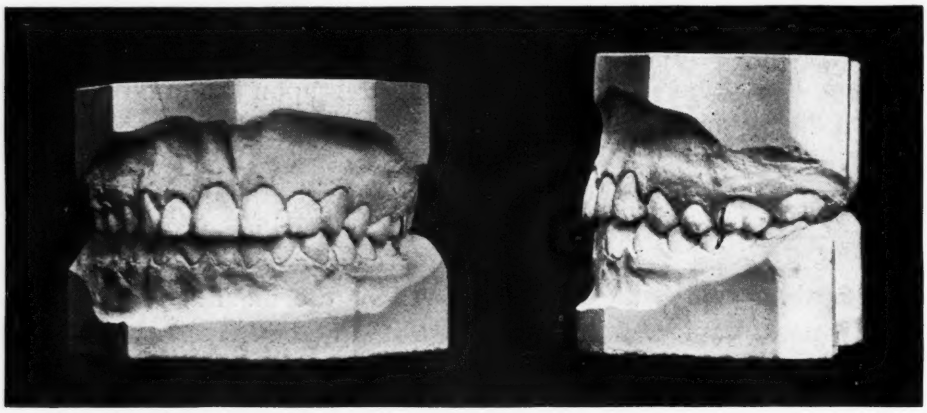

Fig. 1.

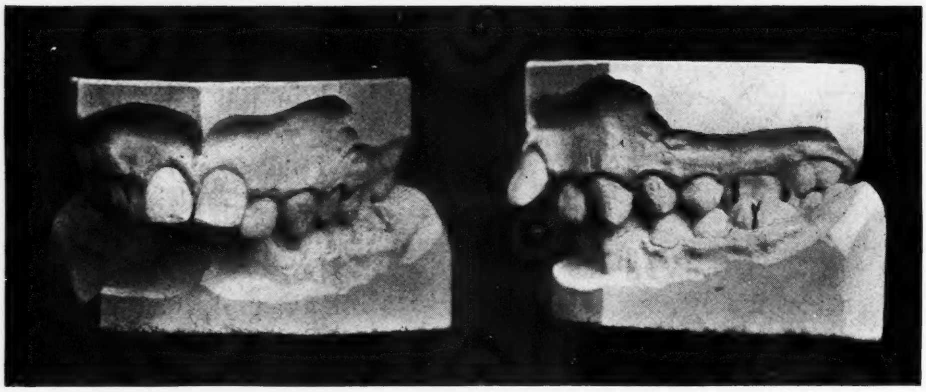

Fig. 2.

The second set of models are those of a mouth-breather. You will see that the upper anterior teeth protrude over the lower teeth and by noticing the marks on the molars you will notice that the lower teeth are distal, or posterior to the upper molars the width of one premolar, or bicuspid. The protrusion of the upper anterior teeth has been produced by the lack of pressure from the upper lip, and forced outward by the lower lip catching under the upper teeth. The condition becomes worse as the patient becomes older, owing to the lack of development of the mandible, and the thickening of the lower lip.

In most of these cases, mouth-breathing persists even after the removal of the adenoids, owing to the inability of the patient to close the lips. These cases are often referred to "as being mouth-breathers by habit", when in

fact they are mouth-breathers because of the difficulty encountered when they try to close their lips. Every child who is operated on for adenoids does not become a normal breather, because very often there is such a deformity of the arches that he can not close the lips without a great effort, and very few of them will make the effort.

It is the duty of every physician to realize that these deformities are progressive, and that the removal of the adenoids is but half of the treatment required. If a greater amount of attention is paid to the deformities in early life, a great amount of good will be done the human family.

THE DEVELOPMENT OF THE HEAD.

By F. Hecker, D.D.S., Kansas City, Mo.

IT has for a long time been known that not all of the bones of the head are developed from cartilage, and that some of them are developed from the soft tissues. The bones that develop in the soft tissues were known to the early anatomists, and by them were termed membranous bones. This term was applied to these bones until about 1845. At about this date active debates were taking place in Europe among the foremost embryologists. After discussions covering a period of a few years, it was agreed among the embryologists to term the bones that develop in the soft tissues, secondary bones. Koelicker, a German investigator, was one of the most active workers in this field, and many of his observations stand today unaltered. Koelicker did not use the term "primary bones," but he used the terms "Belag Knochen" and "Deck Knochen"; these terms were not accepted by many of the embryologists. But after the storm of argument had passed Koelicker continued to use these terms in all of his monographs on this subject. Koelicker proved that after a certain time the primary bones developed by a direct process of ossification in the connective tissue. He also found in his investigations that the dermal bones lie close to the cartilage of the primordeal skull. It is because of this fact that these bones are often termed splint bones.

In the lower vertebrates the membranous bones acquire a greater development than in the higher vertebrates, and in certain ganoids and telosti they are developed over the entire body. In the amniota, the membranous bones are confined to the head.

O. Hertwig demonstrated that the dermal bones are homologous with the plates formed by the fusion of the epidermal teeth. These plates Hertwig called placoid scales. These placoid scales are true teeth developed in the skin, and are developed by thin bases of bone; by the fusion of these bony bases, osseous plates are developed in the cutis. In several of the tailed amphibia, some of the membranous bones arise as dentiferous plates, and in a later stage the teeth are absorbed, leaving the bony plates. In the anura these plates are developed without any teeth. Hertwig's conclusion from these facts is that the dermal skeleton has been evolved through three prin-

cipal stages: First, scattered independent teeth; second, teeth-bearing plates formed by the expansion of the bases of the adjacent teeth; third, membranous bones that develop without any dentiferous character.

It is found that these plates or bones are not the same throughout the vertebrate series. This is especially true among a number of the fishes; here are found a number of modifications the homologies of which have been thoroughly elucidated. In the amphibian head there are encountered all of the elements of the dermal skeleton that are found in the amniota head.

Morphology of the Skull.

The Typical Dermal Bones of the Amniota Head.—In the amniota the dermal bones are confined to the head and the face. Thus we are able to consider them from a comparative point. There are four pair of dermal bones in the amniota head; namely, the nasals which overlie the olfactory chambers; the frontals which overlie the anterior hemispheres of the brain; the middle parietals which cover the middle hemispheres of the brain; and the interparietals which cover the occipital region. These bones with the supraparietals constitute the roof of the skull. When the cartilaginous skull develops, it passes upwards under the dermal bones and it is this portion on ossification that contributes in a greater or less extent to these bones. On using this evidence one can plainly see they are not exclusively membranous in origin. Having considered the dermal bones of the vault of the skull, let us now continue with the other dermal bones. The small lachrymals are situated between the nasals, and the frontals, and the eye on each side. The squamosals occupy the space between the parietals, the alisphenoids, the occipital, and also that portion of the mandibular arch which forms the quadrate in the repitilia. The squamosal is perhaps homologous to the præorbicular of the fishes as is mentioned by Huxley. Balfour says they are a separation of the frontal bone. The bones associated with the palatoquadrate bars appearing in the mouth and the vomer, the palatines, and the pterygoids of a first series. In the second series there are found associated with Meckel's cartilage the distal dental, the small articular, and in the angle between these two bones the angular. In the mammals, there is only one bone developed from the mesenchyma around Meckel's cartilage which is represented by the dental. This point is receiving the attention of many embryologists. One school contends that the preceding explanation is correct; while the second school holds that the development of the mandible is in no way connected with Meckel's cartilage. The series associated with the maxillary process are four in number on each side; beginning on the ventral side they are the pre-maxillæ, the maxillæ, the jugals, and the quadrato jugal. In some of the fishes the parasphenoid is developed in the mouth; this fact is of minor importance in the elasmobranchs, the marsiobranchs, the amphibia, and the serapoida. In the matured adult mouth the parasphenoid is fused with the sphenoid. This bone has not been positively identified in the mammalia, though morphologically it is possibly present in the early stages of the development of the sphenoid. The temporal bone is developed around the ear.

The Dermal Bones of Man.—All of the dermal bones of the amniota have been recognized in man, with the exception of the articular, the angular, the

quadrato jugal, and the parasphenoid; although these bones have not at this time been identified in the mammalian skull they are perhaps represented by quadrate parts; the interparietals by the upper median portion of the supra-occipital, the articular and the angular by a portion of the adult mandible, the quadrate jugular by the ossificatory centers of the jugal, and the parasphenoid by parts of the sphenoid. The nasals, the lachrymals, the vomer, and the jugal remain independent. The palatines are also independent except that they are formed by the union of two pieces. The squamosals, the pterygoids, and the dentals are united with certain parts of the primordeal skull. The premaxillæ is divided into three parts embryologically, the premaxillæ which contains the central and lateral incisors. The remaining portion of the maxillæ is divided into two parts; the anterior portion contains the canines and the premolars; the posterior portion contains the three molars.

The time of ossification of the bones of the cranium of the human fœtus is as follows:

(*a*) The nasals commence to ossify about the eighth week of fœtal life.

(*b*) The frontals commence to ossify from two centers which appear about the seventh week. At birth the point of union of these bones is very distinct; as development progresses the suture is almost obliterated. About the first year the two bones are firmly united into one piece.

(*c*) The parietals are ossified from centers which appear in the site of the parietal eminence about the seventh week. It is this eminence that causes the odd shape of the head so often seen. In some cases this odd shape of the head persists for a number of years after birth.

(*d*) The interparietals are represented by the upper pair of centers of the occipital region; these centers appear in the seventh in the mesenchyma overlying the supra-occipital. In some cases these bones have been found independent of the occipital.

(*e*) The squamosals are each ossified from a single center which appears in its lower part about the seventh week, ossification extends upward and outward to the zygomatic process; at birth the squamosals are still separated from the periotic capsules, but during the first year after birth they unite with the temporal bone.

(*f*) The vomer is developed from a single center in its posterior portion beginning about the eighth week; from this center two lamina are developed which pass up on each side of the median line, and embrace the lower margin of the cartilaginous inner nasal septum. As development progresses these lamina gradually coalesce from behind forward till the age of puberty, thus forming the nasal pit, with the grooves remaining on its superior and anterior margins.

(*g*) The palatines commence to ossify from a single center which appears about the seventh or eighth month, between the horizontal and ascending portions.

(*h*) The pterygoids commence to ossify from a single center which appears about the fourth month; during the fifth and sixth months the pterygoid processes are developed, and unite with the pterygoids. It is by this process that the alisphenoids become the internal plates of the pterygoids.

(*i*) Koelicker was a close observer of the premaxillæ, and according to

his researches the premaxillæ ossify later than the maxillæ. He found that they first appear about the time the palatine suture closes. Koelicker emphasizes the fact that they have a very short independent existence. A primitive division of the premaxillæ is still present about the ninth week. In examining the point of union in the tenth week all division is lost.

(*j*) The maxillæ begin to ossify about the second month from several centers; they rapidly fuse and as a result of this cannot in a strict sense be considered as separate centers. Blanchard is the discoverer of the fact that ossification commenced from several centers. In the description of the premaxillæ it was learned that the premaxillæ and the maxillæ unite about the tenth week.

(*k*) The mandible is a compound bone in the adult. It includes the dermal bones and the ossified portions of Meckel's cartilage. Most of this cartilage is absorbed in the process of development. At the ends of the coronoid and the condyloid process there is seen a cartilaginous development. In a previous portion of this paper it has been stated that there are two schools on the question of the development of the mandible. The principal investigations of the first school are the following. Parker writes that in a fœtus 2.5 m.m. in length he has found Meckel's cartilage in the space between the two pieces of the ununited mandible, and he further states that it is the presence of this cartilage that causes these bones to unite. Masquelin writes that in an embryo 5 m.m. in length Meckel's cartilage is entirely surrounded by mesenchymal bone, and that in an embryo 17 c.m. in length only a slight calcareous remains of the cartilage is noted, except in the lower ends of the symphysis. Koelicker reports that he has seen cartilage in embryos measuring 7.5 c.m. in length. He also reports that he has seen Meckel's cartilage along the alveolar process, and that this cartilage undergoes the process of ossification at an early date. Brock's researches are the basis of the second school. According to his researches the mandible is not developed with the rest of the primordeal skull. He wrote that the accessory cartilage of the mandible is morphologically distinct from that of the primordeal skeleton.

(*l*) The malars, or, as they are some times called, the jugals, commence to ossify about the eighth week. According to the researches of Renault, ossification commences from three centers; about the fourth week these centers unite and all lines of union are lost.

(*m*) The temporals develop from four separate centers which appear about the third month in the external portion of the tympanum, and extend upward until a bony ring is formed that encloses the tympanic membrane. Before birth the open ends unite with the squamosal, and by this union they become incorporated in the temporal bone.

The fontanelles contain open areas at the point of union with the bones with which they unite. At birth they are six in number, two median and posterior, and four lateral. The anterior fontanelle is situated at the anterior-superior angle of the parietal bone; it remains open for some time after birth. The posterior fontanelle is situated between the posterior superior angle of the temporal bone; it also remains open for some time after birth. At birth the bones of the head are very movable. About the first year they become firm in their position, but they are not perfectly united until about the fourth year.

The Relations of the Primary to the Secondary Skull.

Having considered the morphology of the skull from the point of comparative embryology, there has been noticed a wonderful analogy of the development of the head in the lower vertebrate and the higher vertebrate.

The *primary skull* at first appear as a continuation of the mesenchymal skeleton into the head which is analogous to the vertebræ of the neck and the rump. That the mesenchymal skull represents in part at least a series of vertebræ is certain. In the brain there are outgrowths similar to the outgrowths seen in the chord. The mesenchymal skull extends in front of the hypophyses where it produces the trabeculæ of the cranii. The mesenchyma in its growth encases the brain and a part of the olfactory chambers. The skull grows from six centers, namely two trabecular, two pericardial, and two periotic. Each of these form a cartilage which is extraordinary uniform in shape and in relation throughout the vertebrate series. These cartilages soon disappear in the column; the two trabecular are the first to unite; the two pericardial are the second to unite; the two periotic unite at first with the periotic capsules, and later with the ends of the trabeculæ. By this process there is a large floor of cartilage formed under the brain. In the lower forms of vertebrates chondrification spreads until the entire primary skull becomes cartilaginous.

In the amniota and the amphibia there is found a reduction of the cartilaginous skull, and as a result of this reduction the size of the brain is very much reduced. This reduction of size leaves an opening. At once one sees the importance of the dermal bones, for it is these bones that act as the temporary protection of the brain. This opening is much larger in the sarupsida than in the amphibians and the mammalia. Parker in his researches says that he has found this opening larger in the insectivora than in the edentates. In the mammalia there is a loss in the size of this opening that cannot be accounted for. He also writes that there is an absence of chondrification between the sphenoids and the periotic capsule. From this is learned the importance of the sphenoid and the increase in size of the dermal bone of this region. Parker writes that the disappearance of the cartilage under the squamosal is a true diagnostic mark of the mammalian chondrocranium; that the reduction of the cartilage of the branchial skeleton progresses from the lower to the higher vertebrates; first shows itself in the mammalia: by the disappearance of the fourth and fifth branchial arches, and also in the disappearance of the thyrohyoid bones, or the imperfect development of the thyrohyoid bones. A further assertion of this fact is seen in the reduction of the size of the mandible; not only is most of Meckel's cartilage absorbed as in the amniota, but the palatoquadrate is very much reduced in size. In the amphibia the palatoquadrate is one of the important bones of the skull. The palatines and the pterygoids appear as true splint bones in the amphibia, while in the mammalia these bones have a greater independence. From these facts it is logical to conclude that the mammalian skull is dependent to a large extent on cartilage in the process of development.

The secondary skull is not as old as the primary skull. In the higher fishes the secondary skull has its orgin in the dermal plates which lie over the primary skull. It is these bones that almost form a complete cover for the head, and they are also concerned in the formation of the face. A definite

arrangement of these bones is perpetuated in the mammalia; this fact is also applicable to the amphibia. In some of the fishes this condition is seen in a transitional stage. There are some cases in which the splint bones remain, as has been shown in the case of the vomer, or it is found that they coalesce with the upper surface of the chondrocranium, as seen in the interparietals of the primates, or they are found to remain when the cartilage disappears beneath them as in the frontals. As low as in the amphibians co-ordination and fusion of the outer and the inner skulls is seen. This complex process is carried on farther in the amniota; here the dermal bones are of far greater importance than in the amphibia, as the chondrocranium is very much reduced in size. There is no doubt that the mammalian skull has depended largely upon the increase of the morphological prominence of the dermal bones. This process may be designated; first, as the formation of the chondrocranium and the fusion of the dermal bones; second, the evolution of the skull; third, the ossification of the primordeal chondrocranium. From this it is learned that there are three stages in the development of the skull. Scientifically, the advance has been very slow as to the number of points of ossification of these bones. In many cases there is a tendency to reduce the number of points of ossification by fusion. Thus it is that in the head of the amphibia there are fewer dermal bones in number than in the telosti, and that there are fewer in the edentates than in the amphibia, and in man the fewest number of dermal bones are found. By this comparison it is learned that in the ascent from lower to higher vertebrates the dermal bones diminish in number.

Position of the Facial Apparatus.

Owing to the head bend, the oral invagination is brought between the forebrain and the heart on the ventral surface. This is the permanent position in the sharks, and if followed there is seen a steady increase in the region of the olfactory and the oral cavities. The consequence of this process is that the head is thrown upward and the face projects in front of the brain. In man this condition is very much modified: first, because of the upright position of man (for this reason it is necessary to bend the head as in the quadrupeds); second, because of the size of the cerebral hemispheres, it must have an increase in size of the brain cavity. (This enlargement extends principally over the olfactory region); third, in this stage the facial apparatus is very much arrested. During this rest the face in the pig fœtus looks like a large snout. Embryologists have been unable to prove that this condition takes place in the human fœtus.

The significance of the trabeculæ cranii will not be considered to any extent in this paper, as they are of minor importance. Hence it is unnecessary to give them more than a hurried explanation. At the present there is no satisfactory conception of the trabeculæ cranii. It is said they are a temporary stage of the chondrification of the notochord. I am inclined to think that this is improbable and that the rounded areas of the vertebræ offer no explanation of their presence. The morphological condition is determined by the mesenchymal anlage of which the trabeculæ are a part. In none of the literature examined has any investigator accurately described this anlage.

History of the Skull.

The principal theories of the development of the skull will be briefly considered in this paper. It is said that the skull has a resemblance to the vertebræ, and that the greatest thickness of the skull is on the ventral side. It is for this reason that an endeavor should be made to prove the homology of the skull to the vertebræ. This comparison was first made by Vic de Azyr in the early part of the eighteenth century, and it remained the only explanation until Gagenbauer opened an entirely new field in solving the morphology of the skull. The next step was by Foreips on the development of the occiput. Azyr's theory will not be discussed; Gagenbauer's theory will be discussed briefly. In his great work on the salechians he took the ground that the skull does not represent a series of vertebræ; but that it arose from the axial skeleton, before distinct vertebræ were formed in the axial region. He further maintained that the head includes a number of segments of the cranial nerves. This latter statement met with Balfour's approval. At a later date Foreips again stated that the head was developed at the expense of the neck vertebræ.

The present theory is that the primary skull is developed out of the axial skeleton in the region of the brain. In the amniota there is seen the primary skull, which has grown by the annexation of several cervical vertebræ, and that the secondary skull is developed outside of the primary skull by the formation of the dermal bones.

Face and the Mouth Cavities.

The face and the mouth cavities will now be considered in a comparative series. In the marsipobranchs, the ganoids, and the salechians, the face does not form a projecting apparatus. On the ventral side of the head there is an area which is distinguished by including the mouth and the nasal pits. In the marsipobranchs there is a modification of a mouth presenting a large simple sucking apparatus. In the ganoids this sucking apparatus is preserved with little alteration. From this one can conclude why the vertebræ mouth is situated on the vertral side of the head as a simple transverse orifice. So far as we are able to judge, the development of the face depends first on the fusion of the oral and the nasal cavities, which involves a change of position for the hypophyses. Second, there is a partial separation of the oral and nasal cavities and it is this separation that leaves the posterior nares open. Third, by the growth and the elongation of the jaws, which is the most conspicuous indication. Fourth, by the prominent development of the external nose; at the same time there occurs modifications of the position of the face in relation to the brain in its case, the cranium.

Position of the Face.

The position of the face or the oral region in the fœtus is determined by the head bend. One must imagine a median longitudinal section of the head to occupy a direct angular area, and that this area is divided into quarters. The lower posterior quarter corresponds to the mouth region; as the process of development progresses the oral quarter enlarges out of all proportion to the rest of the head. This enlargement increases to such a size that it pro-

jects beyond the forebrain. This is best seen in the amphibia, in which case it results in a large snout. In man it is the least marked, for here the face is covered by the anterior portions of the brain.

Oral Cavity.

When the medullary tube enlarges to form the brain, the head bends over the ventral side to make room for this enlargemtnt; it is the result of this process that the head bend is present in the fœtus. The bending of the head carries the oral plate over the ventral side. At this point there is seen a line that crosses the oral plate. On examining this line it is found to be composed of ectoderm and entoderm. In this stage the mouth is not properly formed. The development of the mouth depends on the development of the brain and the pericardial cavities, both of which expose ventrally a space, and it is in this space that the mouth is developed. Laterally the mouth is bound by a sheet of tissue which stretches from the pericardial somatopleure to the head. This sheet of tissue is called the cheek plate. The mouth in this stage is a shallow fossa. In a fœtus measuring 2.15 m.m. in length no connection is found between the mouth and the entodermal canal. In this stage of development the mouth is lined with entoderm. In a further development the gill pouches begin to form. At about this time the third branchial arch is formed. The oral plate ruptures and the oral fossa communicates with the pharynx upon the lateral and ventral sides. No boundary of the mouth can be found at a later date. On the dorsal side a projection persists, in front of which appears an invagination of the oral fossa that constitutes the anlage of the hypophysis cerebri. Behind this invagination there is a second invagination from the pharynx to form the so-called sessile pocket. In this stage the mouth cavity and the nasal fossa are fused into a single wide cavity. In this stage the shape of the oral fossa does not correspond in shape to the adult oral cavity. In the adult mouth the tongue is present, while in the fœtal mouth it is absent. The tongue is developed from the floor of the pharynx, as was proved by His. The mouth in this stage is separated from the pharynx by the second hyoid arch of the pharynx. In a fœtus measuring 17 m.m. in length the mouth is five-sided. This shape of the mouth is probably characteristic of all of the vertebrates. His offers the following boundaries of the mouth: anteriorly, by the walls of the head covering the forebrain between the nasal cavities; laterally, by the maxillary processes; postero-laterally, by the mandibular process. The latter are the first branchial arches and are unlike the remaining arches that meet in the median line. His says that as the heart migrates from the oral region it moves tail-ward from the buccal end of the pharynx. By this movement the heart leaves the major portion of the pharynx free, and its differentiation from the oral cavity is no longer difficult. In some of the telosti, a short time after the first gill arches appear the mouth breaks through the ventral regions. In the pockets formed by this process there is found a bilateral involution of the ectoderm fusing with the entoderm on each side of a central portion. This was first noted by A. Dorn, and his findings were verified by J. B. Peatt in his researches on the tolesti. McIntosh and Pierce in their researches found that many of the mouths of the telosti had a single and median portion as is seen in the remaining vertebrates.

The Evolution of the Vertebrate Mouth.

This is one of the most puzzling and unsettled problems. Morphologically the question arises, is the mouth of the vertebrates homologous with the mouth of the invertebrates, or is the vertebrate mouth an entirely new structure? The formation of the embryo by concrescence enables us to decide between these alternatives. In the niches and the aniellids there is a well marked concrescence, and the union of the ectental lines is completed. On making a further examination it is found that the anterior and posterior ends do not meet; but the ends of the elongated gastrula are left open to form the mouth and the anus. In the aniellid the mouth is carried inward by the vorderderm; the mouth after this process is a simple opening into the vorderderm enteric canal. In those vertebrates in which the process of concretion is present, it is said this is the stage in which the vertebrate mouth begins to develop. It is in this stage found surrounded by an ectodermal neural plate forming the brain and the esophageal commissures, and the ventral nerve chains. These points corresponding, the mouth is easily found in the vertebrates located between the optical invaginations which in all probability correspond to the future infundibulum in position. It has been found in the study of the early development of the vertebrates that there is no known communication with the archenteron, and until this point is positively settled, it is impossible to state the positive origin of the mouth. Granting all that has been said as to the origin of the mouth is correct, our attention is attracted by two alternatives. The first is, as has been shown, that the vertebrate and the invertebrate mouth are identical in origin. The second is, that the old mouth is represented by the hypophysis; from this it is learned that neither of the structures are derived from any part of the gastrula. In the aniellid the brain lies in front of the mouth. This is also found in the vertebrates in certain stages of development. From this analogy one could say that the mouth of the vertebrate and the aniellid are the same at a certain stage of development. In the aniellid the brain almost entirely disappears as the process of development progresses, while in the vertebrates the brain becomes almost entirely a new structure. On making a careful examination of the infundibulum we find that it is an invagination of the ectoderm, toward the archenteron. It is developed at near a point where the vertebrate mouth lay. It is quite possible that it corresponds in its orgin to the vorderderm of the aniellids. This last statement has not been positively proven up to the present, although it has for the last fifteen years received a great deal of attention morphologically. Dorn advanced the theory that the vertebrate mouth represents two gill slits united in the median line. The principal facts of Doran's theory are: first, that the trigeminal nerve shows the same relation to the mouth as do the other cranial nerves; second, that the clefts approach the median line anteriorly; third, that the membrane is formed like the membrane across the gill cleft.

A short time after Dorn advanced his theory Semper and Balfour published their theories. Semper wrote that he had observed a small pit on the dermal side of the head, and that after this pit had reached a certain depth it was connected with the archenteron, and by this union he said a new mouth was formed. Balfour wrote that the mouth in the vertebrates and the aniellids arose from ancestors that had lateral nerve chords, and by the

union of these chords a median central chain is found in the aniellids. In the vertebrates by the union of these chords a dorsal chain is formed. The theory of Dorn is at present the one used by embryologists.

Hypophysis.

The hypophysis cerebri was discovered by Rathke. Embryologists have speculated a great deal as to the function of this body. In the vertebrates it arises as an invagination of the ectoderm near the dorsal border of the oral plate, and it is separated from the oral plate by a thin fold of the ectoderm. This is most beautifully seen in the petromyzon. In a monograph written in 1879 by Koelicker on the hypophysis, he writes: "A small groove is seen in front of the oral plate, at which time it does not have the form of distinct invagination, but after the oral plate reptures, it takes on the form of a distinct invagination. The ectoderm of the mouth is firmly attached to the ectoderm of the brain". This last point has been most generally overlooked by embryologists. Kushman writes that after the oral plate ruptures a portion of it remains upon the dorsal side, and he says that it is this portion of the oral plate that separates the hypophysis from the pharynx. By many embryologists this theory is not accepted; but as they do not offer any other theory it is safe to use this one in explaining this process of development. Minot says that with the disappearance of this fold, there arises a new fold which is filled with mesoderm; in other words, on the disappearance of this fold a new fold of ectoderm is formed, and this new fold is filled with mesoderm. Minot says this new fold is homologous with a fold of the character seen in the petromyzon. In embryos 13½ days old there is found a diverticulum of the oral cavity with one wall attached to the brain, and another wall is formed by a fold which divides the hypophysis from the mouth. In this stage the epithelium of the mouth and the hypophysis is one layer thick. On close microscopic observation the process of karyokinesis is seen with little difficulty. This process is confined to the epithelium, being seldom seen in any other part of the body during development. In the posterior portion of the mouth there seems to be a connection of the hypophyses and the caudate. Rathke on finding this described it as being developed from the archenteron.

In later investigations it was found that the diverticula elongates and expands at its upper end, the lower end remaining unchanged in size. About this time an outgrowth appears behind the hypophysis, which is an anlage of the infundibulum, and the two walls of the diverticula have united. Minot writes that the union of the hypophyseal area, over the buccal and cerebral ectoderm, is possibly a mechanical one. On examining the diverticula at this time it is found that development is progressing very rapidly, that the pedicle elongates, and its lumen is being obliterated. The mesenchyma in this stage is commencing to condense, and the sphenoid is commencing to develop. In the rabbit this stage is about the sixteenth day. Lazet reports that in the examination of 100 children he found ten in which this condition existed. In the pig the vesicle becomes flattened in a longitudinal direction; in shape it resembles a yoke; in section it at first is convex toward the forebrain, and concave in its center toward the infundibulum. In rabbits it is developed by sending out hollow buds from the anterior wall. In birds it is

developed from two buds one on each side, which elongate as development progresses. In the birds branches are given off from the buds in various directions, and among these branches there are found blood vessels. In the rabbit the diverticula separates from the parent, and after this separation it continues to grow as before. On the disappearance of the lumen the hypophyseal chords are developed.

In the mammals the infundibulum contributes to the production of the hypophyses; but in the lower vertebrates it is found to persist as an integral part of the brain, and that it is differentiated into ganglion tissue. W. Müller found this first in the amniota, and in later researches on the pig and the sheep. In a sheep embryo 35 m.m. in length he found that the infundibulum had a pointed end which often elongated and afterwards developed. On further researches he found that after a certain stage it had taken on a knob-like appearance, soon after which it is lost in the cavity. After this stage it differentiates itself into nervous tissue. The cells of this tissue microscopically take on an indifferent character. In this stage it is firmly attached to the brain and is penetrated by blood vessels and connective tissue.

The Nasal Pits.

The nasal pits begin with the differentiation of the oral plates, which are two thickened areas situated in the front of the mouth, in actual contact with the brain. It is from these plates that the olfactory epithelium is developed. In the petromyzon a very interesting variation occurs, here is seen a pit that extends from the analogue to the hypophysis. From this fact it is probable that some of the vertebrates had one nasal pit. In as low a type of vertebrate as the lampreys a division is seen. The nasal pits are divided into two pockets, right and left. On a further examination of these pockets it is found they are supplied by divisions of the olfactory nerve, which is distributed to the respective parts. Balfour writes that this plate is divided at an early date in the vertebrates. A. Goette argued that the nasal pits are not formed by the invagination of the olfactory plate; but that they are formed by an upward development of the epiderm and the mesoderm around the plate. This growth he claims takes place on the middle and lateral sides of each plate, and it is by this partition that the two pits are formed. Minot writes that the development of the nasal pits is the same as the development of the hypophysis; that is, that there is a union of this plate with the brain wall. In early life the nasal pits are very shallow, and the olfactory plate is exposed laterally. On the lower border of the plate there is seen a small depression which is analogous to Jacobson's organ.

His writes that there are two important changes which take place in the development of the nasal pits; first the growth of tissue around the olfactory plate, and second the migration of the pits away from the brain. At this time he says the nasal pits are very shallow fossæ and that a ridge of tissue is forming around them. This ridge of tissue does not extend into the oral fossa. Hence it is found in this stage that the nasal pits communicate with the mouth. On making a further examination it is seen that they are very widely separated from each other by a mass of projecting tissue, which Minot calls the nasal process. Between the nasal pits and the mouth on each side an analogue of the nasal process is found, which is thick and round,

and forms a protuberance. This projection was by His called the processus globularis. The nasal process occupies the space which lies between the nasal chambers and the analogue of the future nose, and also the intermaxillary region of the upper lip. The maxillary process extends between the mouth and the eye, and also toward the nasal pit. At a later time it unites with the processus globularis. The point of union of the maxillary process and the processus globularis marks the separation of the nasal and buccal chambers, the upper border of the mouth is completed by the union of these parts. As soon as this process is completed the external nose is developed. The posterior opening of the nose is above the palate shelf. His in his researches found that the palate is developed from the oral fossa and not from the nasal cavity. In man the labyrinth of the nose commences to develop about the third month by three folds—the upper, the middle, and the lower turbinate folds—at first each is a duplicate of the ectoderm filled with indifferent mesenchyma. The upper, middle and lower turbinate folds soon take on an early change, and it is in this change that they become cartilaginous; as the process continues they undergo ossification. After the turbinates are well along in the process it is found that the labyrinth has continued to develop into outgrowths that on completion become the ethmoidal sinuses. In man these sinuses appear in the sixth month. The antrum of Highmore is an expanded portion of the nasal cavity into the region of the maxilla. There are also two other invaginations which form the sinuses found in the frontal and the sphenoid, which do not arise in man until after birth. The separation of the olfactory plate does not occur until after the olfactory ganglion is formed. In the chick this division takes place about the third day of fœtal life.

On examining the newly born child it is learned that the olfactory fibers are very much elongated, and that they are separated from the neural epithelium by the cribriform plate of the ethmoid.

The external nose is developed toward the end of the second month: in the third month it is very broad, its shape resembling the negro nose very much in this period of development. This condition does not exist very long, for it is soon found that the external nares and the wings of the nose are carried forward and that the nose is at this time commencing to grow upward. During the third month the nares are closed by a plug of epithelium; but this plug is soon absorbed, and about the fifth month all traces of the plug are no longer present and the nares are free.

The Maxillary Process.

It has been shown that there is a thickening of the upper edge of the mouth, that this thickening is a continuation of the mandibular arch, and that from this thickened portion the maxillary process is developed. At first this thickened portion appears like a small bud, and at a later stage it stretches farther forward, and the mouth is now changed in shape from a pentagonal form to a transverse slit. In this stage the maxillary process no longer appears to be associated with the mandibular arch, but is now connected with the edge of the nasal process. Minot says that this last statement is probable but that up to the present it has not been positively proven.

The Mandibular Arch.

The first brachial arch forms the lower boundary of the mouth and by its development grows into a projecting lower jaw.

The Lips and the Gums.

Very soon after the upper jaw has been formed, and the maxillary process unites with the nasal process, its surface develops two parallel ridges. The outer ridge becomes the lip, the inner ridge becomes the gums. An analogue of this process is seen in the lower jaw. In the sixth to the seventh there is developed a peculiar epithelium of the lips, that appeared in the strata lucidum and the epitracheum. In the rabbit thirteen days old the epitracheum is seen running over the region of the future lip. In the pig embryo measuring 3.5 m.m. the epitracheum is still present, but in places it is commencing to show an enlargement of the basal cells and cornification is beginning.

THE HISTORY OF ORTHODONTIA.

(*Continued from page* 458)

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Dentistry During the Hebraic Age.

THE main sources of our knowledge of medical history of the Hebrews are the Bible and the Talmud. Notwithstanding their intimate relations with the Egyptians and the close proximity to the other surrounding tribes, medical science never reached the degree of development among them as it did with their neighbors.

The principal interest displayed by the Hebrews in a definite direction were the efforts in preventative medicine, yet in hygiene were they most pre-eminent and distinguished. Moses makes the first reference to physicians, about 1640 B.C. "Joseph commanded his servants and the physicians to embalm his father."[1] These physicians were no doubt Egyptians.

In the Bible many allusions are made to the teeth, yet no specific reference in early Hebrew literature to dentistry is shown. It is strange that in the excellent sanitary laws drawn up by Moses for safeguarding the health of the people under his care, none are on record for the care of the teeth and mouth. We are thus led to the presumption that the teeth of the ancient Hebrews were sound and healthy. In the "Songs of Solomon," reference is made to the beauty and whiteness of the teeth in the following words. "The teeth are like a flock of well selected sheep, which are come up from the washing."[2] This passage, with a slight variation occurs again,[3] showing

1. Genesis 5-2 2. IV-2. 3. VI-6.
Most of the above detail, as well as those on dentistry throughout this work is taken from "A History of Dentistry," By Dr. Vincenzo Guerini.

how beautiful teeth were appreciated by him. That the "full compliment of teeth" was appreciated by Moses is shown by the criminal code in which he states in the book of Exodus (XXI, 23-27):

> 23. And if any mischief follow, then shalt thou give life for life.
> 24. Eye for Eye, tooth for tooth, hand for hand, and foot for foot.
> 27. And if he strike out his man-servant's tooth, or his maid servant's tooth, he shall let him go free for the sake of his tooth.

Broken and decayed teeth are referred to as symbolic of weakness, "Like a broken tooth and a foot out of joint, is confidence in a treacherous man in a time of distress."[4] Again, "Arise, O Lord, help me, O my God, for thou smitest all my enemies upon the cheek bone; the teeth of the wicked dost thou break."[5]

Sumerian and Babylonian Dentistry.

The Babylonians, Assyrians, Egyptians, Hebrews, Greek, Romans and Brahmas, were among the early cultured nations of whom historical records exist, their priests were the embodiment of the clergy and our professional man, they were the doctors, surgeons, astronomers, lawgivers, and scientists, as well as "voices of the gods".

In the libraries of China, Alexandria and Memphis, were records of their learnings, probably containing valuable medical and dental literature. As in the case of the pillaging of the Alexandrian Library during the seventh century, when the Saracens invaded and subjugated Egypt, devoting six months to the destruction of books, records, etc., so other hostile tribes plundered the great libraries of their times.

"Before the advent of the Babylonians, it is supposed that an original non-Semetic or Sumerian race existed, (about 4000-3000 B.C.), which laid the foundation of modern civilization by the invention of pictorial writing and the development of astronomy. Others assume that the cursive script of the Sumerians, which like Chinese writing runs from right to left, was in the first instance only a sort of a cipher-code used by the dominant Semetic race. In any case, Mesopotamia was the starting point of Oriental civilization, of which the Babylonians were undoubtedly the principal founders."[6] They were the inventors of the cuneiform inscription, reading from left to right. Among the hieroglyphic records recently excavated in Babylonia and transcribed by Deletzsch, Thompson and others, are found some interesting accounts concerning the practice of medicine and dentistry.

Like the Egyptians, the Babylonians reached the stage where they had physicians for every disease, but whether dentistry was practiced as a separate branch we do not know. They employed the same methods as the Egyptians in treating the sick, requiring those who were ill to be brought to the market place, in order that whoever passed and had been so afflicted might advise as to how they were cured or had escaped similar diseases. Montaigne quaintly observed, "The whole people was the physician." We learn, however, from the code of King Hammurabi (2250 B.C.,), a contemporary of Abraham, that the medical profession in Babylon advanced far

4. Proverbs of Solomon XXV:19.
5. Psalm: III:8.
6. Garrison Fielding, H.: An introduction to the "History of Medicine."

enough in public esteem to be rewarded with adequate fees carefully prescribed and regulated by the law. "Thus ten shekels in silver was the statutory fee for treating a wound or opening an abcess, if the patient happened to be a 'Gentleman':if he were a poor man or a servant, the fee was five to two respectively. If the doctor caused the patient to lose his sight or life, he had his hand cut off in the case of a gentlemen, or had to render value for value in the case of a slave."[7] Among the records found in recent excavations, are a number of interesting facts concerning the practice of dentistry under Hammurabi. "If one knocks out a tooth of one of his own cast his own tooth shall be knocked out, while if it is a freeman, he pays one-third mine silver. Severe punishment, however, was in store for the surgeon if he operated on the critical days of the month Schall-Elul (Leap Year), viz., 7th, 14th, 21st, 27th."[8]

The earliest method for treating "tooth-ache," of which we possess records, is that practiced by the ancient Babylonians, who believed that caries was the result of the gnawing of small worms at the tooth, a belief that remained prevalent until recent times. The following incantation was recited with the hope that it would prevent further destruction of the tooth:

"After Anu (had created the heavens),
The Heavens created (the Earth),
The Earth created the Rivers,
The Rivers created the Canals,
The Canals created the Marshes,
The Marshes created the Worm.
Came the Worm and wept before Shamask,
Before Ea came her tears—
What wilt thou give me for my food
What wilt thou give me to devour?
I will give thee dried bone,
And scented . . . . (wood)
Let me drink among the teeth,
And set me on the gums,
That I may devour the blood of the teeth
And of their gums destroy their strength,
Then shall I hold the bolt of the door."

After chanting this three times, the patient was directed to rub the gums with a mixture of beer, a certain herb and a pungent oil, the names of which cannot at present be indentified.

The Dental Art of the Greeks.

It is Greece which furnishes the most interesting records of the history of medicine during antiquity. For over seven hundred years medicine underwent a transformation, being practiced by shepards, then becoming sacred and finally wrapped in mystery. We must go back to the Greek philosophers to find any knowledge concerning the teeth.

Nothing of consequence is to be found in the early history of Greece, time having destroyed everything. It is known that about 300 B.C. Erasistratus deposited, in the Temple of Apollo, a forceps, and instrument of lead, for the purpose of extraction of the teeth.

7. Ibid.
8. Prinz, Hermann: Dentistry in Early Folklore, "Old Penn," Jan. 16, 1915.

We find no reference to dentistry or other sciences, during the first century of Greek civilization. To the time of the siege of Troy (1193 B.C.) the writings of the early Grecians consisted almost entirely of hymns to the gods. Homer has failed to mention the subject in his works, although he relates that the teeth of warriors were broken; yet he does not tell what was done to replace the same. According to Cicero, extraction was first advised by the third Æsculapius, son of Arsinoe and Arsippi (1300 B.C.,) who also recommended cleansing the mouth and teeth. According to this, dental surgery had its origin with Æsculapius, the "God of Medicine" and most ancient authority on medical science.

It is not known whether the above tradition, related by Cicero, is authentic, but as there were numerous temples of healing dedicated to Æsculapius in almost every large Greek city and to them came the sick seeking relief, so we may presume that dentistry must also have been practiced at this early period.

Celius Aurelianus records that instruments of lead was used for extraction of the teeth, one having been deposited at Delphi in the Temple of Apollo. It is not known, whether this was simply a model placed there for anyone who wished to copy it in other metal, or kept there in order that physicians might become acquainted with the same. Herodotus and Aristotle give us some information concerning the treatment of the teeth, mention ing such instruments as "scrapers" and "extractors", thus dental surgery must have been known to the Greeks at this time.

Solon (640-558 B.C.) noted that the deciduous teeth were replaced by permanent ones about the age of seven years, and Democrates alluded to the falling out of the teeth and its causes.

As the Hippocratic period is approached a gradual advance in medical knowledge may be noticed, and that the care of the mouth was considered of importance.

Hippocrates, founder of Greek Medicine, came of an Æsculapius family at Cos (460-355 B.C.). Never before, or since, have so many great men of genius lived within the short period of time. His first medical instruction was received from his father, studying at Athens, and acquiring extensive experience in travel and practice among the cities of Trace, Thessaly and Macedonea. "The eminence of Hippocrates is three-fold; he dissociated medicine from theology and philosophy, crystallized the loose knowledge of the Coan and Cindian Schools into systematic science, and gave physicians the highest moral inspiration they have."[9] To him medicine owes the art of clinical inspiration and observation.

Hippocrates instituted for the first time, a careful systematic and thorough examination of the patient's pulse, temperature, respiration, excreta, sputum, localized pains, and movements of the body.

In his writings are found the earliest known literature pertaining to the teeth, a crude description dwelling mostly upon the phenomenon of nutrition and upon the disorders of which they are the cause. He describes the function and the period of eruption of the teeth, and probably was the first to recommend the use of a dentifrice. Living in an age of superstition, he

9. Garrison, Fielding H.: History of Medicine, p. 65.

had the ability to discover natural causes and the courage to proclaim them in spite of long rooted prejudices.

"There is", he says, "a glutinous increment from the bones of the head and jaws, of which the fatty part is dried by heat and burnt up, and the teeth are made harder than other bones, because there is nothing cold in them."

In his works there is no one chapter devoted to the teeth, but a great number of passages scattered throughout the collection. In the book *De Carnibus* the formation of the teeth is spoken of among other things: "The shedding of the first teeth generally takes place at about seven years of age, those that come forth after this grow old with the man, unless some illness destroys them."[10]

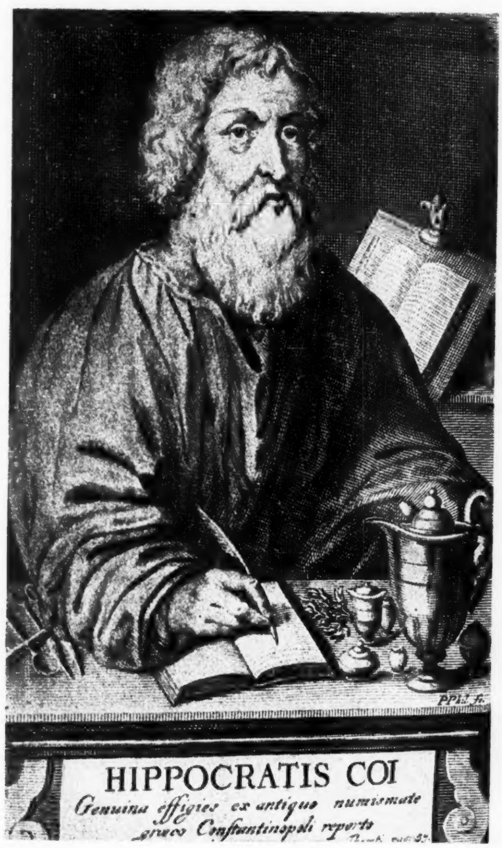

Fig. 1.—Hippocrates (460-355 B. C.). Probably the first to notice irregularity of the teeth.

Another passage in this same book alludes to the clear pronunciation of words and the importance of the teeth. "The body attracts the air into itself; the air expelled through the voice produces a sound, because the head resounds. The tongue articulates and by its movement coming in contact with the palate and the teeth, renders the sound distinct."[11]

Perhaps to us the most interesting passage recorded in his works is found

10. Hippocrates: De Carnibus, p. 251.
11. Ibid., p. 253.

in the sixth book of *Epidemics*:* "Among those individuals whose heads are long-shaped, some have thick necks, strong members and bones; others have strongly arched palates, their *teeth are disposed irregularly*, crowding one on the other, and they are molested by headaches and otorrhea."[12]

It is surprising to learn that these relations were noticed, and that so close attention was paid to the palate during the time of Hippocrates. It is more than interesting to know that the relation between irregularity of the teeth and malformation of the skull and palate is not new, and that there was knowledge on this subject twenty-four centuries ago.

Hippocrates also refers a number of times to fractures of the jaw, which was evidently not infrequent in his time. In speaking of fractures of the jaw, he recommends "binding the teeth together on the right and left of the lesion."[13] "After having carried out the coaptation, the teeth ought to be bound one to the other, this greatly contributes to obtaining the immobility of the fragments, particularly if properly carried out.[14]

"In the case of tooth-ache if the tooth be decayed and loose it must be extracted. If it be neither decayed nor loose, but still painful, it is necessary to desiccate it by cauterizing. Masticatories also do good, as the pain

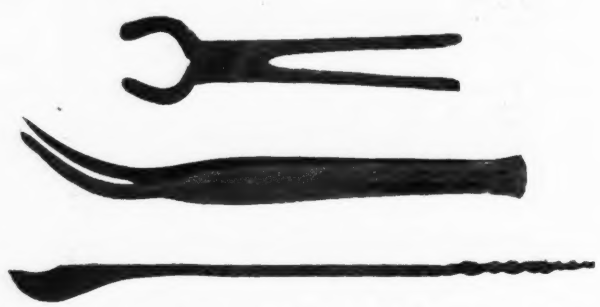

Fig. 2.—Ancient Greek forceps, and two other dental (?) instruments. (From the Archaeological Museum of Athens.)

derives from pituita insinuating itself under the roots of the teeth. Teeth are eroded and become decayed partly by pituita and partly by food, when they are by nature weak and badly fixed in the gums."[15]

The use of carbonate of lime or chalk dates back prior to the time of Hippocrates, being used as a basis for a dentifrice mixed with the head of a hare and the intestines of mice.[16] Vinegar as a mouth wash was recommended by Hippocrates,[17] as well as one composed of castorium and pepper, which was found efficacious in cases of toothache.

He refers to the use of instruments, in his work entitled "*De medico*", mentioning the instruments and articles necessary for a physician's office.

*The works of Hippocrates are usually divided into four groups, the genuine, the spurious, the works of his predecessors, and those of his contemporaries and followers. The genuine writing are the aphorisms, (Book I-III) treatise on prognosis. On epidemic diseases, (Book I & III), wounds, dislocations, fractures and ulcers, and that on "Air, Water, and Places." The *opkos*, physicians oath, is not regarded as his, but thought to be an ancient temple oath of the Asclepidas. For this reason we cannot say positively that it was Hippocrates who first noted irregularity of the teeth and the relation between this and the malformation of ths skull and palate.

12. Hippocrates: De morbis vulgaribus lib., vi, section i, p. 1164.
13. De articulis, p. 800.
14. Ibid., p. 799.
15. De Affectionibus, p. 507.
16. De morbis mulierum lib., ii, p. 666.
17. De liquidorum usu, p. 426.

Among many, was the pincers for extracting teeth, "Any one can handle them, because evidently the manner in which they are used is simple."[18]

There is no doubt some form of artificial appliances were known for replacing lost teeth. In the Archæological Museum at Athens are several specimens of early Greek workmanship that had been used for such purposes (Fig. 3). The upper figure illustrates a form of bridge composed of metal in which a tooth is inserted; the lower figure illustrates a bridge of four teeth, bound together by wire, and as Hippocrates mentions the use of gold wires, no doubt it was this material that was used in the lower jaw.

We thus learn by the number of references to dental diseases, instruments and bridge work that has been unearthed, that Hippocrates and the Greeks attached a great deal of importance to the dental arch and teeth.

Aristotle, pupil of Plato and tutor to Alexander the Great, the greatest philosopher of his age, and founder of the science of anatomy, lived about seventy years after Hippocrates (384-322 B. C.). He gave to medicine the beginning of zoology, comparative anatomy and embryology. In embry-

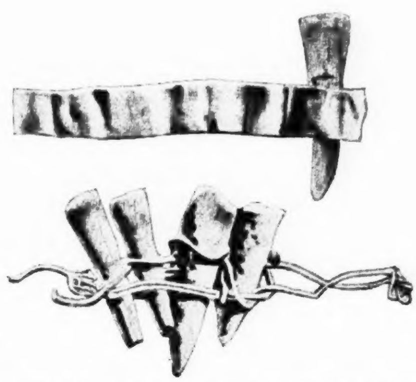

Fig. 3.—Ancient Greek Artificial Teeth. (From the Archaeological Museum of Athens.)

ology he noted the fact of the movement of the fetal heart, in comparative anatomy he was the first to use the term "anthropoligist", but not as it is used today.

He was the first to devote a chapter of any length to the teeth, examining them in relation to their comparative anatomy, noticing there was not only a difference between the human teeth and those of inferior animals, but between species of the latter. The number and forms of the teeth varied in animals according to their food and service they are put to. In man they serve mainly for mastication, and are also of use in assisting articulation of words and in the pronunciation of certain letters.

Aristotle has given us much information, of which some is the basis of our principles today; but he falls into some curious errors, such as, that a man has more teeth than woman, and that the same difference exists in the sexes of some animals, such as the monkey; that human teeth increase in length during life, and thus they differ from other bones. The following translated extract will give a fair notion of the extent of dental knowledge attained in those days.

18. De medico, p. 21.

In another book, devoted to mechanics, he refers to extraction in the following words: "Why do doctors extract teeth more easily by adding the weight of the odontagra (dental forceps) than by using the hand only? Can it be said that this occurs because the tooth escapes from the hand more easily than from the forceps? Ought not the irons to slip from the tooth more easily than the fingers, whose tips being soft can be applied around the tooth much better? The dental forceps is formed by two levers, acting in contrary sense and having a single fulcrum represented by the commissure of the instrument. By means of this double lever it is much easier to move the tooth, but after having moved it, it is easier to extract it with the hand than with the instrument."[19]

There were other authors, Diocles, Herophilus, Heroclides and Erasistratus who spoke of the serious trouble that might arise by careless extraction of a tooth, and recommended great care in this respect.

Diocles, a famous Greek physician during this same century, did not favor extraction, and strongly recommended treating the tooth with a mixture composed of saffron and cedar gum.

19. Guerini, V: History of Dentistry, p. 64.

EXCERPTS

Prevention of Malocclusion.—(B. Frank Gray, D.D.S., Colorado Springs, Colo. (*Dental Summary*).—It is quite commonly stated among the best practitioners of dentistry today that the public is demanding the services of our profession to a far greater extent than was true ten years ago. It is my belief that the activities of individual dentists and of dental organizations which seek to educate the public in oral hygiene is the chief cause for the impetus which has been given our work.

True enough, the efforts of the conscientious dentist for many years have been aimed at prevention—in a sense: prevention of pain, and the prevention of the further depredations of dental caries. But is is that conception of prevention which looks to the protection of the dental structures from an *environment* which *invites* disease, that has claimed the thought of so many of our best men in recent years.

Malocclusion of the teeth *ought* to be *prevented.* It is as far-reaching in its pernicious influences as any of the conditions which confront the profession. Deformed dental arches; unhygienic mouth; carious teeth; mouth-breathing; distorted and inharmonious faces—these are the results of malocclusion.

The prevention of malocclusion is so *perfectly possible* that every practitioner of dentistry surely should be keenly alive to the situation.

The teeth of the decidious denture *must* be kept healthy and intact for their normal period of usefulness. Under no circumstances may a first or second decidious molar be allowed to decay or be lost prematurely. If, unfortunately, such a tooth *is* lost, its space must be retained mechanically until the succeeding tooth erupts. Once the permanent molar drifts forward into the space of the second deciduous molar, a basis of serious malocclusion is established.

What I have said about the deciduous molars is quite as true of the deciduous incisors and canine teeth.

Orthodontists are continually expending their efforts to overcome the influences of neglect. Every dentist should have definite knowledge as to the average normal period of life of the deciduous teeth, and see they are retained approximately that time—or indeed until the succeeding tooth is clamoring for eruption.

Again, in a few cases, the deciduous tooth, for some reason, is prone to remain too long in its position. The reasonable procedure in such a case is to determine, by means of skiagraphs, the progress toward eruption being made by the permanent teeth. If well along toward eruption, and the age of the patient indicates its wisdom, let the deciduous tooth be removed.

Strangely enough, the deciduous denture of some children (say at the age of four to seven years) is much underdeveloped. As the child approaches the period at which the permanent incisors should erupt, there should be in evidence a constant widening of the dental arch, and the so-called normal "*growth spaces*" should be appearing between the deciduous incisors and cuspids. In many cases the "*growth spaces*" are wholly lacking. This, of course, means that the permanent incisors, with their greater width, cannot possibly find accommodation in the space occupied by the small deciduous incisors. So here is an opportunity for prevention that should not be overlooked. Gentle mechanical stimulation of the development, laterally, of these arches, should be resorted to, even at a period of two or three years previous to the appearance of the permanent incisors. Dr. Barnes, of Cleveland, has called such particular attention to this that I think his name should be mentioned in this connection.

In dealing with malocclusion, the advice to wait until all the permanent teeth have taken their positions, Dr. Brady once said, is equivalent to telling the parent to allow the case to get as bad as possibly *can* get, before making any effort to correct it. The successful treatment of malocclusion, which is at all complicated, is *tedious* and *exacting,* and requires a quality of presistence and fitness on the part of the operator that is only fully realized by those who have actually engaged in the work. Any fee that will compensate the operator,

even in a modest degree, for his services, may prove a burden to the parent, if, indeed, the orthodontist is not accused of "highway robbery." A child of twelve or fifteen years of age, with much irregularity, requires a treatment period of the greater part of one year, with a succeeding retention period of two years' time.

Because of the requirement as to time, and the consequent fee demanded in these established or somewhat "mature cases," only one out of the many can ever be treated. Possibly one out of seventy-five or a hundred cases only, will have the services of the orthodontist—and in communities where there is no specialist the proportion of treated cases is practically nil. The result is that hundreds of thousands of children all over the land must go on through life with varying degrees of dental and facial deformity, much of which could have been prevented by the intelligent co-operation of the family dentist.

In filling teeth with gold, certain well-defined principles are adhered to in order to arrive at a certain degree of success. So, out of all the chaotic beliefs with reference to treatment of malocclusion of teeth, certain well-defined basic principles have finally been accepted by those who have thought most upon the subject. The great fundamental in orthodontia is *normal occlusion!* To work to any other principle is to acknowledge a degree of defeat at the outset.

A brief resume of the avenues of prevention of malocclusion might, therefore, be as follows:

(*a*) The preservation of the deciduous teeth for their normal life period.

(*b*) The mechanical retention of the space if the deciduous tooth be permanently lost.

(*c*) By nothing to decidious teeth are not retained for a considerable longer time than is normal.

(*d*) By stimulating the lateral growth of the decidious dental arches when the normal "growth spaces" are not in evidence say, at six years of age.

(*e*) By paying some attention to the naso-pharynx and nose to see that the child has no occlusion of the air passages.

(*f*) By bearing in mind that prevention is better than cure.

(*g*) By remembering the best time to correct existing malocclusion is *now.*

If the question be asked: What mechanical procedures may the general practitioner follow in dealing with incipient malocclusion ? I may reply:

1. Where the second deciduous molar, for instance, is lost, he may fit and solder a band to the first permanent molar; another to the first deciduous molar; connect the two bands by means of soldering a strong wire between them, and cement the little appliance thoroughly to place. Inspect it at intervals of three months until the second bicuspid makes it appearance.

2. The dentist may stimulate the lateral development of crowded deciduous arches by means of bands fitted to the cuspid teeth on either side to which a soft lingual wire is soldered, the ends passing a bit distal to the cuspids, to engage the lingual aspect of the first deciduous molar. With a suitable wire-stretching device the wire may be gradually lengthened, thus securing a considerable degree of expansion of the anterior part of the arch. This method will not successfully move both crown and root of the cuspid, as may be done by some of the newer methods.

3. The dentist may note the influence of an abnormally attached frenum-labium in causing serious separation of the permanent central incisors, and may, by following a fairly simple technic, put an end to the abnormal muscular attachment, with the electro-cautery—drawing the teeth together and retaining them pending the eruption of the lateral incisors.

4. If the dentist considers this work, even in its simpler phases, undesirable or burdensome, in most communities of considerable size he may co-operate with a specialist. In any event, let us not unthinkingly pass by conditions, which in their incipiency work no great ill, but the neglect of which is fraught with consequence which scarcely the full purse of the patient and the skilled hand of the operator may fully correct.

Mastication and Food Utilization.—Again and again in everyday life we find that some dictum which either commends itself to common sense or lends itself freely to argumentative proof is being made the basis of a widespread propaganda. What was more reasonable than to assume that water ingested with meals would dilute the gastric juice and thus diminish its proteolytic efficiency? And what was more logical than to urge the abolition of such an assumedly harmful custom of

water drinking? Yet investigation has showed that some of the postulates in this contention are wrong, and that unsurpassed factors further vitiate the conclusions. Indeed, under certain conditions water may even promote the gastric secretion, and thus upset these revered traditions.

The proper mastication of food has certain obvious justifications. It promotes a more extensive insalivation, which is not without advantage to certain types of foodstuffs, and it permits a speedier admixture of the alimentary digestive secretions with the individual comminuted food particles. Enthusiasts have not been content with the insistence on these indisputable advantages, but have attempted to infuse far-reaching effects into the habit of every complete mastication. We may be ready to admit that insufficient mastication is the cause of direct or indirect evils which may be greatly exaggerated in certain pathologic conditions. When, however, we are urged to chew our food with unremitting vigor because it "secures proper insalivation of food, increases the quantity of alkaline saliva passing into the stomach, stimulates the heart and circulation, influences the nutrition of the jaws and their appendages by stimulating blood and lymph circulation, and, finally, tends to diminish the amount of food consumed because it is more economically disposed of in the system," one may well pause to make a few related inquiries. Where is the boarderline between "truth and poetry" in these matters?

The two extremes of practice are doubtless represented by undermastication, as involved in the hasty bolting of food, and overmastication, to which the epithet "fletcherizing" is sometimes applied. Foster and Hawk have completed studies of the utilization of typical protein as influenced by different degrees of mastication. The principal protein constituent of the diet was cooked beef in the form of 15-millimeter cubes. It happened that protein utilization was most complete as the result of good mastication, and last complete when bolting was practiced. The output of fecal nitrogen was highest during the food bolting, and macroscopic meat residues appeared in every stool under such conditions. Yet the discrepancies in the protein utilization during these extremes of mastication averaged only 1.6 per cent.

Such insignificant differences surely cannot be used in support of any enthusiastic claims for the alleged marvelous efficiency of the excessive mastication of food, even when judged by the other extreme of food bolting. In another recently published series of experiments on man in which vegetable products, notably potatoes and cereal breads, formed the prominent articles of diet, utilization was apparently improved by good mastications. Neither these nor the earlier quoted results are to be taken as an appeal for complete indifference in the matter of eating, but rather as an indication of the rationality of that happy medium of performance in mastication which is usually a sign of physiologic wisdom in other functions.—*Jour. of the American Medical Association*, Aug. 28, 1915.

Taking the Occlusion and Registration of the Condyle Path.—By *O. Amoedo*, Hon. President of the Societe Odontologique de France, Hon. Prof. of the Ecole Odontotechnique de France. (Read at the XVIIth Inter. Med. Congress, London, 1913.—*Ash's Monthly*, August, 1915).—Numerous are the investigators who have arrived at the conclusion that the condyle paths vary greatly in different individuals in their angle of inclination as they pass forwards and downwards. I have found variations of no less than 35° between the right and the left side in the same person.

The question arises, How are we to recognize the inclination of the condyles in different individuals, and thus determine the true occlusal compensating plane? My observations have lead me to the conviction that the dental arch neither presents a curve of compensation nor a curve of Spee, but, in fact, two occlusal planes. I will therefore begin by an exposition of the occlusal plane of the dental arches.

In children up to ten and twelve years of age, all the teeth of the upper arch rest upon the occlusal plane; in other words, if the upper arch of a child who has changed all his upper teeth is placed upon a flat surface, the four incisors, the two canines, the four bicuspids, and the two molars—in all, twelve teeth—will all rest upon this flat surface.

This is the occlusal plane of the dental arches—an immutable plane, for it will be the same in the child, in the adult, and in

old age. To it all measurements of the dental arch will correspond, as well as those as the condyle path.

This occlusal plane is parallel with a line drawn from the inferior part of the external auditory meatus to the insertion of the ala of the nose; it is the auriculo-naso-labial line.

When in the adult person the occlusal plane is prolonged backwards, the arches closed one upon the other, this plane passes on a level with the distal side of the neck of the inferior wisdom tooth.

At the appearance of the second and third molars another plane is formed at a mean acute angle of 15° to 20° with the occlusal plane. This is the compensation plane, and the angle thus formed will constitute the compensation angle. This plane, if projected forward, passes by the labial side of the neck of the lower incisor.

I propose to call the anterior plane the "occlusal plane," and the posterior one the "compensation plane," instead of "compensation curve" and "Spee's curve," for they in no way correspond to an anatomical reality, nor do they find any application in prosthesis, whilst the planes which I propose considerably simplify and facilitate the understanding of the problem of articulation in artificial teeth.

The angle formed between the compensation plane and the occlusal plane is in direct relation with the inclination of the condyle path. I have found, with Gysi, that a condyle path of 40° corresponds, on an average, with a compensation angle of half that size—that is to say, 20°.

The sliding surface of the palatine face of the superior incisors is also in relation to the condyle path, and with the compensation angle. A sliding surface of 80° corresponds to a path of half that size, (40°) and a compensation angle of one-quarter (20°).

The overbite of the incisors is also subordinated to the same angles. A path of 40° corresponds with a lapping over of the incisors of $2\frac{1}{2}$ mm.

Where there is no inclination of the condyle path—that is to say, when the condyle executes the protrusive movement horizontally—the incisors will articulate end to end, without overbite. The molar cusps and the direction of their occlusal surfaces are also in direct relation with the condyle path. A very inclined path corresponds with long cusps: the upper ones have their occlusal surfaces very much inclined outwards and downwards, and the lower ones upwards and inwards; that is to say, the mastication surfaces of the upper ones will be inclined towards the cheeks and the lower ones towards the palate.

These anatomical data will find their reasons in the physiology of the dental arches. Thus, when the subject makes a movement of prehension with the incisors, the condyle comes down from the glenoid cavity, slipping forward under the condyle protuberance of the temporal. The lower incisors are also lowered and thrown forward, in order to place their cutting edge in contact with the upper incisors. This is the anterior point of contact.

The second and third molars are also lowered and thrown forward in order to enter into contact with the posterior part of the occlusal surface of the first upper molars. These are the posterior points of contact.

If, in the case of an inclined condyle path, instead of being placed upon two planes (anterior and posterior), the teeth are all placed upon one straight plane, there will be a loss of contact at the level of the molars in the protrusive movement of the jaw, and the incisors alone will join.

But the ingenious disposition of the posterior occlusal plane compensates this loss of contact of the molars, and that is the reason why I call it the "compensation plane."

In this protrusive movement, the canines the bicuspids, and the anterior part of the first molars must not touch each other.

When the jaw executes a lateral movement, in mastication, one side of the dental arch is always in relation with that of the opposite side, as well as with the condyle path of the opposite condyle on which mastication takes place.

Thus, for example, when mastication takes place on the right side, the whole series of upper and lower vestibular cusps will enter into contact, and so will also the cusps of the lingual side, upper and lower.

On the left side, alone, the lower vestibular cusps will take contact with the lingual cusps of the upper molars. When mastication takes place on the left side, the same relations occur, but in the reverse manner.

The knowledge of these few anatomo-physiological motions of the dental arches is necessary before entering upon the study of dental prosthesis. The failure of so

many practitioners in using anatomical articulators must be attributed to ignorance of these preliminary motions.

I am well aware that these beautiful and harmonious anatomical laws become less and less observable among inhabitants of large cities, and among those of high altitudes and near the sources of large streams, such as Switzerland, Tyrol, Rocky Mountains (U. S. A.), Jujui (Argentine), Rio de Janeiro (Brazil), North of Spain, etc. In such high regions we find affections of the thyroid gland (goitre) allied to bad and decayed teeth.

But even if we admit that these laws have outgrown our contemporaries, which is far from being the case, their application to prosthesis is absolutely indispensable, both in view of the mechanism of mastication as well as of that of the retention of the apparatus.

The glenoid cavity itself presents considerable variations among our contemporaries. I presented at the Society of Stomatology of Paris a young man of twenty years of age in possession of his thirty-two teeth; I took the impression on his dental arches, and registered the condyle paths by Christensen's method. When the models—which I now present to you, were mounted upon the articulator, I was surprised to find on examining the condyle paths that the right path measured 25°, whilst that of the left side measured 35°, or a difference of 10° between one side and the other.

Thinking I had made a mistake, I took the measurement of condyle path by Gysi's method, and Dr. Solbrig measured it by that of Eltner. The result was the same—25° and 35°. But the most conclusive proof consists in moving the lower jaw of the articulator laterally to and fro, when the cusps of all the teeth will be seen to articulate exactly as in the mouth, and if the direction of the condyle path is changed the cusps do not articulate regularly; some of the cusps strike against each other, whilst others do not meet at all.

It can be easily understood that if the condyle path presents such a difference (10°) in a subject who is in possession of all his teeth, the difference will be far greater in a subject who has gradually lost his teeth in the course of his life.

At the March session of this year (1913) I presented to the Society of Stomatology a full set of teeth which I constructed for a lady having a condyle path measuting 15° on the right side and 50° on the left—that is, a difference of 35°. These measurements showed, in the placing of the teeth, that there existed a compensation plane on the left side and a single plane on the right. The dental arches articulated perfectly in the mouth and in all their movements, and, strange to say, I did not have to correct the cusps in the least.

I consider it useless to insist upon the necessity of registering both condyle paths, the case I have just quoted showing it super-abundantly, but I may add that in the United States it is indispensable to learn to take the direction of the condyle paths and that of the anatomical articulators before going up for examination at the Dental Universities and the State Boards.

Let us now see how to proceed in order to take the occlusion of the alveolar arches and register the condyle paths. Before I begin I would like to settle a point of nomenclature. I mean by "occlusion" the closing of the dental arches one upon the other in a state of rest, when both the mandibular condyles are situated at the bottom of the glenoid cavities; whilst the "articulation" indicates the contact of the arches during the movements. Occlusion is the static state; articulation constitutes the dynamic state. Now that we have fixed this point, let us proceed to the facts.

I make use of two independent waxes to take the occlusion, one for the lower and another for the upper arch. I prepare them by fixing the wax upon low godiva plates; they must be well strengthened by a solid wire. These waxes must give us the exact and reciprocal relation that the alveolar arches had when the subject was in possession of all his teeth.

Several processes have been put forward to overcome the difficulties presented by certain subjects to all of taking these measurements. Dr. Garretson even had an apparatus constructed by which he forced the condyle to remain in its cavity whilst taking the occlusion; I must tell you, however, that I have had this apparatus in my possession for the last fifteen years, and I have only been obliged to use it two or three times. When you know how to do it, it needs but to call the patient's attention to something else. By depressing the head there is a difficulty in bringing the chin forward. It is also possible to make the patient touch the back part of the palate with the tip of his tongue,

whilst taking the occlusion. Another manner is to cause the patient to swallow his saliva. In short, the practitioner has at his disposal many processes which he can apply, according to the patients.

But, admitting that the patient bites the waxes normally, it is important to determine the height of the lower wax, that of the upper one, and that of the total of both waxes.

We have seen, on studying the dental arches, which are the landmarks of the occlusal plane. In the case of an endentulous subject it is sufficient to introduce a spatula between the waxes of the base plate, just touching the upper lip, and parallel with a line drawn from the external meatus to the insertion of the ala of the nose on the upper lip.

We have thus the occlusal plane and the height which corresponds to each wax: in order to determine the total height of both the waxes, Tarpitz's compass will give it mechanically.

I had occasion to control the measurements given by this compass on subjects having all their teeth, and I have always found the proportions to be perfectly accurate. In the case of edentulous subjects, when the required height has been found with this instrument, it will be seen that the facial appearance of the patient is quite satisfactory as far as aesthetics are concerned.

We have determined the normal relation between the alveolar arches, and we are in possession of the occlusal plane upon which the twelve teeth of the upper jaw will be placed.

We have now to calculate the overbite which will have to be given to the lower incisors, and what will be the compensation plane upon which the occlusal surface of the second upper molar will have to be set.

The inclination of the condyle path will give us the necessary answer.

There are different ways of obtaining the registration of this path: some take, upon the face of the subject, the graphic of the condyle movements; others register, upon waxes in the mouth, the movements of the jaw. Bonwill used, in this case, the occlusion waxes, which he cut, and gave them what he called a "compensation curve," until obtaining for each movement an exact articulation with his waxes. Walker, in 1896, registered the graphic with an apparatus which he called the "facial clinometer"; and he invented at the same time a physiological articulator with a variable path. I fancy I am the only one to possess a specimen of this articulator imported into Europe; and as to the clinometer, he is, to my knowledge, the only person who makes use of it.

It was not until 1902 that Christensen resolved the problem of registering the condyle path, by giving us a simple method within reach of all practitioners.

In 1908, Gysi published a remarkable work on the problem of articulation. He gave a new method of taking the condyle path, and invented an anatomical articulator with a modifiable condyle path and rotation centre. I at once sent for these appliances, and travelled expressly to Switzerland to learn their working from the inventor himself. They are the most perfect appliances in existence, and I make use of them in particular cases with good results, but in current practice I give preference to the method which I shall presently describe.

Eltner, in 1909, introduced a new method of registering the graphic of the condyle, and invented a very ingenious anatomical articulator, but equally difficult to apply to daily practice.

Gysi has lately inproved upon the registration of the condyle movements. He now registers the lateral movements, which vary by 10° to 30° in relation with the median line. He modified his articulator in order to allow it to show these angles on the condyle path.

I fear, however, that these new difficulties, added to the relatively high price of these appliances, will only retard the use of Gysi's method.

In order to prevent complications, I have given to the cursors of my articulator an average lateral movement of 15°.

But let us return to the occlusion base plate, which I take out of the mouth after having obtained the relations of the alveolar arches, the height (by means of Tarpitz's compass), and the occlusal plane.

I make grooves upon the waxes in order to guide myself later on, when they are cool; I put them back into the mouth, and place between them, at the height of the bicuspids, a ball of softened godiva about the size of a small nut, on the right and the left sides.

I now request the patient to bite with forcible protrusion; I cool the wax down with cold water and take both waxes out, firmly held together by the godiva balls.

I then separate the godiva balls from the articulation waxes and put them aside. They have been flattened down in the mouth, and bear the prints of the grooves I cut upon the waxes. The size of the godiva balls may seem exaggerated, but it is necessary they should be so, in order to keep the relations that have been registered.

We have now to measure the distance between the alveolar edge and the condyles at the height of the incisors.

Bonwill found that there was an average distance of 10 cm. between the two condyles, and that this distance was equal to that which separates each condyle from the junction of the lower incisors. The models must therefore be mounted on an anatomical articulator, placing the incisors region at 10 cm. from the condyles.

But as this distance varies from 7 to 13 cm., according to the subjects, it is preferable to adjust the models at the distance required for the patient for whom the work is done. I always make use of Snow's face-bow.

This instrument has a fork which is fixed in front of the waxes. The two ends of the bow are fixed upon the condyles, in front of the tragus.

The models may now be mounted on an anatomical articulator on which the face-bow can be fixed. I mount them upon my articulator, which is constructed to receive the face-bow.

Our present object is to regulate the condyle paths. I take up again the godiva balls and put them between the waxes, which must be fixed on the upper model. I repeat on the lower jaw of the articulator the same protrusion movement which the patient had executed.

The condyle cursors place themselves automatically at the degree of inclination which I had registered in the mouth of the subject.

If the cursors locate themselves horizontally, it is a sign that the subject has an insignificant path, of less than 10°; and in that case all the teeth must rest upon the same plane of occlusion, without compensation plane and without overbite of the incisors.

But if, on the contrary, the cursors are very much inclined—say 40°—it will be necessary to place the second molar at a considerable angle—20°—on the occlusal plane. The incisors will have an overbite from 2 to $2\frac{1}{2}$ mm.

There are, of course, many graduations between these extreme cases, and even with the same subject we may find a difference of 35° between the right and the left side, as I have shown just now.

CONCLUSIONS.

1. The upper dental arch presents a straight occlusal plane, which comprises twelve teeth—four incisors, two canines, four bisucpids, and two molars; this plane is parallel with a line (ariculo-naso-labial) which goes from the lower external auditory meatus to the insertion of the ala of the nose, on the upper lip.
2. Another plane, called "compensation plane," is formed by the second and third molar.
3. A simultaneous contact between the incisors and the molars must take place during the protrusion movements of the jaw.
4. Before beginning the construction of a set of teeth it is necessary to take into account the state of the glenoid cavity, by a registration of the condyle path.
5. The twelve upper anterior teeth must be located on the occlusal plane, and the second molar on this same straight occlusal plane, if the condylian path is horizontal, or inclined upwards, thus forming a compensation plane if the condylian path is inclined.
6. When the plates are finished they must fit in the mouth as well as in the anatomical articulator.

DISCUSSION.

Mr. E. Lloyd-Williams (London) thanked Dr. Amoedo for his communications. Whilst admiring the excellent work done by many investigators in delineating the condyloid path, he was of opinion that to imitate that path in making prosthetic cases for edentulous jaws was entirely wrong from a practical point of view. In his experience, which was not a short one, he believed that a flat articulation, deeply cut, but not interdigitated in any way, was the only practical method of getting the best results. A little articulating paper and common sense were used in individual cases, and many movements of a patient which could not be generalised were compensated for by grinding the teeth. He laid stress on rigid base-plates for taking the articulation in the mouth, and said that wax plates under no circumstances were admissible.

Mr. Douglas Gabell (London) said he differed from Mr. Lloyd-Williams; he believed that the use of compensating curves on artificial teeth was of considerable value. Unfortunately we did not yet possess an articulator that would exactly imitate the movements of the mandible; the best ones did so only approximately, and so the results were not yet as improved as they might be. In partial cases these defects were made evident. Also in full sets the amount of stability of the plate limited the steepness of angle of the incisor movement; too near an approach to the natural angle causes dislodgement of the dentures. The path of the condyle was not only in the vertical plane, but also in the horizontal plane.

He objected to the method used by Dr. Amoedo for ascertaining the condyle path, because, firstly it was necessary by a small difference in position of the alveolus to determine a large movement of the condyle, so that a small error in the first would make a greater error in the latter; and secondly, the bite blocks from which the latered position of the alveolus was ascertained were resting, not on uncompressible bone, but on a yielding gum, and the pressure required to mould the wax or composition would inevitably depress the blocks and give too great an angle for the condyle path. The method was correct in theory, but too delicate to apply in practice. Gysi's method was more accurate, and capable of being tested for mistakes in technique by using both the opening and closing and also the lateral movements in order to get the same tracing of the condyle path.

Dr. Cruet (Paris): I have seen Dr. Amoedo's articulator and its movements. I am obliged to say that I am not at all in agreement with my *confrere* Dr. Amoedo; or, rather, I think he is making a useless effort in trying to find an ideal articulator. This is not the first discussion that I have had on this subject with Dr. Amoedo, for he has already presented four or five ideal articulators in Paris.

Dr. Amoedo is trying to find a mechanical and physiological articulator, although he does not call it such; but from the very fact of these two terms being used together, the principle from which Dr. Amoedo starts is bound to be misleading.

Dr. Zsigmondy (Vienna) said it is not only necessary to study the movements of the lower jaw in general, but especially those that are executed during the time of actual mastication. He thought the best way to find out these would be to fix the eyes on one particular point in the lower jaw, whose movements could be regarded as representative of the movement of the whole jaw. As an inward movement on one side is an outward movement on the other, it seemed to him best to select for that purpose a neutral point, belonging at the same time to the median plane and to the masticatory plane—broadly speaking, the contact point of the lower incisors. In the movement of mastication there could be distinguished two different movements—the movement of opening and the movement of shutting. In opening, the incisor point never goes down in the median line (as it would do in speaking). It is always to one side or to the other side that it moves in going down. After attaining the greatest depression the shutting movement is executed in the shortest way possible to the resting position (occlusion). He never could produce any masticatory effect when he tried to move the jaw from one side to the other. At the time these observations were made he had still all his teeth; he had lost one meanwhile.

Dr. O. Amoedo (Paris): Mr. E. Lloyd-Williams said he has abandoned the curve of compensation and, in every case, makes a straight line in all the full sets of teeth. I will answer our *confrere* that in general he is right, for the averave 35° of the condyle inclinations given in 1896 by Dr. Walker, and reduced later by Dr. Gysi to 32°, are still too high.

My observations led me to reduce this inclination to an average of 20° to 25°. With this inclination of the condyle path, we can give the second molar an angle of compensation of 10° or 12½° resepectively.

But it is unnecessary to give a compensation curve on a straight one in all cases, no matter what condyle inclination we have to deal with.

To Mr. Gabell I may say that I am acquainted with Gysi's methods, and just three months ago I met him in Geneva at the Odontological Congress of Switzerland where he explained to me the mechanism of his latest articulator with recordable lateral movements. I know also the "New Century" articulator.

I will reply to Dr. Cruet, who tells us

that he has not been able to understand my communication in English, which I regret, because it is not a question of an anatomical articulator only. In the work which I have just had the honor of submitting to you, it is more especially a question of the study of the rules and of the anatomical and physiological indications of the temporomaxillary articulation and of the dental arches, which study enables us, in a methodical and reasonable manner, to take measurements, and puts us in a position to make scientifically conceived apparatus, without leaving anything to chance or to the empiricism of former times. Dr. Cruet tells us that he has never been successful with mechanical articulators, and that he finds the best articulator is the mouth of the patient. In that we are perfectly in accord; but as I cannot entrust the mouth even of my patient to my mechanic, I am obliged to take exactly all the measurements of the static and of the dynamical condition, and to mount the models on an anatomical articulator, capable of making the same movements as those of the patient under treatment.

Concerning Dr. Zsigmondy's observations: they need no answer, as they are the result of facts registered by himself.

Gentlemen, in closing, I will say that as stomatologists, having had the privilege of making a full study of anatomy, and physiology, our duty is not to leave anything to the empiricism and guess-work of the past. We have now at our disposal elements which permit us to take, at the chair, all kinds of measurements, in order to fulfill our task scientifically. Thus guided, our mechanical collaborators will find half of their work already done, and the trials in the mouth should be reduced as much as possible.

Though the subject is still rather new for some professional men, experience has already ratified the efficaciousness of what I have described before you; and my last word will be to remind the teachers of prosthesis in dental schools to enforce the study of anatomy and physiology of the temporo-maxillary joint, in its relation with the dental arches, upon their new professional *confreres.*

NEWS AND NOTES.

Dr. Ralph T. Huff, practice limited to orthodontia, has announced his removal to Suite 1742-1744 Marshall Field Annex Building, 25 East Washington Street, Chicago.

Doctor George Bernard Crozat, announces that he has opened offices at 1224 Maison Blanche, New Orleans, La., for the exclusive practice of orthodontia.

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EDITORIALS

The Imitator.

IF you would leave an impress upon the world of thought and action, don't imitate.

The man or woman who dares to stand alone in thought, has a boundless universe in which to live and work. Nature is limitless; the discovery and understanding of one secret is but the torch that lights the way to another victory. There is no barrier to progress but that erected by oneself.

Conventionalities, customs, environments and heredity are links in the chain that bind the mediocre and the ordinary to the chariot wheel of the demagogue. Man is by inheritance a lazy and indolent animal. It is easier to follow a path made by the feet of the chain gang than to cut and grade a new road. The blazed trail is the one most sought by the great majority. Blazed trails never lead to anything that someone else has not already discovered.

The imitator is the vulture to human achievement. It is the dead hand that would paralyze initiative, stifle effort, and dry up the spring of hope and courage. It would perch in its sombre garb over the cradle of new thoughts, new ideas, and great ambition. It would strangle in its icy grasp the great dreams of human progress, it would drape its banner of defeat over the forces of civilization and would turn back in their course the stars of human grandeur.

The imitator is a coward, afraid of his own opinions, he dances like a naked savage in the quiet glow of what another has done. He is a squaw man, subsisting on the fruit of another's toil. Afraid of himself, afraid of imaginary ghosts and goblins which a distorted mind has thrown around him, he breaks for cover whenever thrown upon his own resources.

The imitator stands for nothing. The varying winds of fortune change his viewpoint at will. He makes no advancement, being content to take the husks and crums that drop from the hands or are kicked aside by the pathfinder. He is content to build a shack in the shadow of a palace and to bask in the reflected light of what others have accomplished.

The imitator's name is legion. His is the rule rather than the exception. He is on every hand with his grinning death head. He stalks about like the prowling hyena, ready to pounce upon every bone and morsel that he can find; but creates nothing, warms nothing, and lights none of the dark places of the Earth with a beneficient glow.

A Correction.

THROUGH error the following references were omitted from the bibliography of the paper by James D. McCoy, D.D.S., of Los Angeles, on "The Consideration of Constitutional Disorders as an Etiological Factor of Malocclusion of the Teeth in Children," which appeared in the August issue of the Journal:

Clarence J. Grieves, "The Relation of the Internal Secretory Organs to Malocclusion, Facial Deformity, and Dental Disease, " Dental Cosmos, vol. lvi, No. 8.

Edmond H. Pond, "Internal Secretions", Dental Cosmos, vol. lvi, No. 10.

John Bethune Stein, "Syphilitic Hypoplasia of the Teeth," vol. lv., No. 7.

Martin Dewey, "Practical Orthodontia."

What Shall The Harvest Be?

THE dental schools opened October first with the largest number of freshmen on record. This influx into the ranks of dentistry is evidently due to the lengthening of the course in 1917, and to the raising of entrance requirements by medical universities, thus closing the doors to many who would otherwise take up the study of medicine. A number of dental schools have actually been unable to accommodate all who applied for entrance, and now have a waiting list for 1916. This condition prevails at the Northwestern and Washington Universities, and no doubt at many others.

In looking over this array of new recruits to the dental ranks, one is prone to draw aside the veil, and, looking into the future, ask, "What will the harvest be?" The exacting demands that are now being made by society upon members of the dental and the medical professions, renders it necessary that the utmost care be exercised by those who are engaged in dental education lest unfit material fill up the ranks. It is obvious that nothing is more unjust than to allow a boy to take up the study of dentistry when it is apparent to the most casual observer that he is unfitted for the task.

Manufacturers are today applying efficiency tests to the mechanic and endeavoring by scientific procedure to detect the "square plug in the round hole," and thus obviate human waste. Should it not be equally incumbent upon dental educators that the prospective students be culled with the utmost care, and only those accepted who possess the necessary qualifications to succeed in their life's work?

The foremost medical universities of this country are trying their utmost to keep down the number of students. This is done primarily because none but the best fitted to succeed in medical practice should be encouraged to take up its study, but also because it is only by careful selection that a high rate of failures can be obviated.

Nothing is more pitiful than to see a student put in three or four years attempting to get a dental or medical education and fail at the last barrier. Why not be frank with such material in the beginning and stop the waste before so much valuable time is spent? It is lamentably true that a great percentage of our young men who graduate in dentistry and medicine make dismal failures out of their work. Frankness may be brutal, but sometimes it is necessary to be cruel to be kind.

Would it not be a kind and charitable act to turn back the knowingly unfit who clamour to enter the dental and the medical profession? Is it not more necessary to have the successful farmer, mechanic and merchant, banker and manufacturer, than the ne'er-do-well or complete failure in the dental profession? With this viewpoint on dental education, as one looks out upon the crop of freshmen gathering in the autumn days of 1915, he is prone to ask himself the question, "What Will the Harvest be?"

Recognition of the Dentist by the Clinical Congress of Surgeons.

ON October 25th there will gather in Boston the flower of American Surgery. This will be the sixth annual meeting of the Clinical Congress of Surgeons. The retiring president, Dr. John B. Murphy, will be succeeded by Dr. Chas. H. Mayo.

This society is almost identical with the Royal College of Surgeons in Great Britain, and it has done much for the advancement of American Surgery.

In looking over the program of this meeting one is surprised, but greatly pleased, to see the recognition that this body of scientists pay to the dental profession, and especially to orthodontia and oral surgery.

At the Forsyth Dental Infirmary there will be held daily clinics on dental radiography, on orthodontia and extracting. The Research Laboratory of this institution will be open daily to those attending this convention between the hours of 9 and 12 and 2 and 4.

This recognition of the work of the dentist by the surgeon is encouraging to those who have at heart closer amalgamation of these two professions. It bespeaks more efficient survice for both professions, and much good to the public.

The thanks of the dental profession are due the program committee of the American Congress of Surgeons. Already the founders of the Forsyth Infirmary are seeing the wisdom of their bequest. Such institutions thrice bless, their greatest blessing may be in the unification of the two great sciences, medicine and dentistry.